Introduction

Assessment Advantage LLC has an agreement with the Association of African Universities (AAU) to review selected master’s programs at three Centres of Excellence (ACE) at Nigerian universities to provide a gap analysis of the actions needed to bring each selected program into conformance with the criteria for accreditation of the Engineering Accreditation Commission (EAC) of ABET. The three universities, the relevant center of excellence (ACE) if any, and their programs selected for a gap analysis review are:

African University of Science and Technology (AUST) in Abuja  
ACE: Pan African Materials Institute (PAMI)  
Program: Materials Science and Engineering

Obafemi Awolowo University (OAU) in Ile-Ife  
Centre: ICT-Driven Knowledge Park  
Programs:  
   - Computer Engineering  
   - Intelligent System Engineering  
   - Software Engineering

University of Port Harcourt (UniPort) in Port Harcourt  
ACE: Center for Oil Field Chemicals Research (CEFOR)  
Programs:  
   - Petroleum & Gas Engineering  
   - Petroleum Engineering & Project Management

The Assessment Advantage consultant review team for the review of these programs was:

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ABET accredits a program based on whether the program satisfies a set of criteria for accreditation by an ABET commission and the requirements of a set of ABET policies and procedures for accrediting programs. The reviews that have been conducted by the Assessment Advantage review team for the AAU universities are based on an analysis of the reviewed programs relative to the ABET EAC criteria for accreditation and the applicable policies and procedures. It should be noted that the consultants are highly experienced in conducting ABET program reviews and in consulting to assist programs in preparing for an ABET accreditation review. However, the consultants do not speak for ABET. The findings of the consultants documented in this report are the consultants’ own best evaluation of the status of the program relative to the requirements of the ABET EAC Criteria for Accrediting Engineering Programs and the ABET Policies and Procedures Manual (APPM), and are not an evaluation by ABET or the ABET Foundation.

Note also that ABET criteria change from time to time. The consultants’ review was performed using the ABET EAC criteria that are currently in effect. However, an effort is underway to review EAC General Criteria 3 and 5, so it is likely that any future review of the program by the ABET EAC could use a different set of criteria than the current criteria that were used by the consultants.

This report is for the Computer Engineering, Intelligent System Engineering, and Software Engineering programs at Obafemi Awolowo University (OAU). The report is based on information that was provided to the review team prior to an onsite visit, and information obtained by review team members during an onsite visit to the university on June 21-23, 2017. Unless stated otherwise, all statements in this report apply to all three programs.

The Program

The Computer, Intelligent System, and Software Engineering programs at OAU are administered by the Department of Computer Science and Engineering in the Faculty of Technology at OAU. These programs are new, and as yet have no graduates. It should be noted that ABET requires that any program that is reviewed for possible accreditation must have at least one graduate from the program.
Program Analysis Relative to ABET EAC Criteria for Accreditation

This section contains an analysis of the program relative to each of the relevant ABET EAC criteria, including recommendations to strengthen the program in preparation for a review for accreditation by the ABET EAC. It should be noted that the analysis of the program in this document is relative to the current ABET EAC document, and that it is likely that the criteria will change over the next few years. Any change in the ABET EAC criteria will require a reassessment of the program relative to each part of the criteria that is changed.

Although ABET recognizes that a program may use its own appropriate terminology and ABET does not require a program to adopt the ABET terminology, within the ABET criteria the following definitions apply:

**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.

Program analysis:

The program educational objectives (PEOs) listed in the self studies do not conform to the ABET definition for PEOs. A key concept is that PEOs are statements of what graduates are expected to accomplish within three to five years after graduation. For example:

Graduates will be successful in the development and deployment of computing products that address local problems as well as meet international standards.

Some of the stated PEOs might be rewritten to conform to the definition, but some are more oriented to general goals of the department and cannot be reworded as professional accomplishments of graduates.

The PEOs also are supposed to be based on the needs of the program’s constituencies. The documentation on the programs does provide some general
philosophical objectives for the programs, including contributing to the needs of the region. However, an ABET review team normally expects to see some evidence that constituents are involved in determining appropriate PEOs for the program, such as having employers and graduates of the program involved in periodically reviewing the PEOs for possible revision. One common way to do this is for a group of employers and graduates, such as an external advisory board, to review the PEOs periodically during a meeting and to suggest revisions, if any, that it feels are needed. These reviews are usually held every 1-3 years.

The statements of student outcomes (SOs) in the self studies for the programs did conform generally to the ABET definition for SOs. However, only one SO was listed for each program. In general, more than one outcome for a program would be expected. Some of the outcomes could be the same for all three programs.

Recommendations:

1. The programs must adopt a set of PEOs that conform to the ABET definition.

2. A process for periodically reviewing whether the PEOs meet the needs of the program constituencies (employers and graduates) should be implemented.

3. Adopt additional student outcomes for each of the three programs.

The remainder of this section evaluates the program relative to each of the stated criteria for master’s-level programs.

**Criterion: Students and Curriculum**

*Criterion statement (part 1):*
The master’s program must have and enforce procedures for verifying that each student has completed a set of post-secondary educational and professional experiences that:

a) Supports the attainment of student outcomes of Criterion 3 of the general criteria for baccalaureate level engineering programs, and

b) Includes at least one year of math and basic science (basic science includes the biological, chemical, and physical sciences), as well as at least one-and-one-half years of engineering topics and a major design experience that meets the requirements of Criterion 5 of the general criteria for baccalaureate level engineering programs.

*Student Outcomes from General Criterion 3:*
Student outcomes are outcomes (a) through (k) plus any additional outcomes that may be articulated by the program.
(a) an ability to apply knowledge of mathematics, science, and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(c) 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
(d) an ability to function on multidisciplinary teams
(e) an ability to identify, formulate, and solve engineering problems
(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
(i) a recognition of the need for, and an ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Major design experience requirements of General Criterion 5:
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.

Program analysis for part 1:

Note that this criterion requires that by the time of graduation from the program, the program must have procedures to ensure that the students have had certain educational experiences. These experiences can occur at any time during the student’s total post-secondary educational and professional experiences, which would normally be during the student’s undergraduate education, postgraduate preparation work prior to joining the master’s program, or during the master’s program itself.

a) Students admitted to the programs must possess an appropriate bachelor’s degree. However, there is no guarantee that every student’s undergraduate work “supports the attainment of student outcomes of Criterion 3”. Applicants who are from undergraduate engineering programs in Nigeria and other African universities might have completed work that supports attainment of some or all of these outcomes, but that is not verified in the admission process. Furthermore, such verification would be tedious and difficult to do accurately, if at all. The requirement can still be met, however, if the combination of the undergraduate and graduate work supports attainment of each of the Criterion 3 outcomes. If, for example, it can be shown that the required course work for a master’s program supports attainment of each of the Criterion 3 outcomes, that would be sufficient and no detailed examination of the undergraduate work of admitted students would be needed. However, the small number of required courses in the OAU master’s programs will make it difficult to
demonstrate that every student has course work that supports attainment of each of the Criterion 3 outcomes.

b) Students admitted to the program who hold an appropriate bachelor’s degree would be expected to have completed at least one year, (30 semester hours) of mathematics and basic science. This is not verified during the admission process, however. If an admitted student has not completed at least 30 semester hours of mathematics and basic science then additional work must be required to make up the deficiency.

Students admitted to the program with a bachelor’s degree in engineering would also be expected to have met the requirement for at least a year and a half (45 semester hours) of engineering topics, but this also is not verified during the admission process. Furthermore, students admitted without an undergraduate engineering degree would almost surely not have completed many, if any, semester hours of engineering topics. Again, the requirement can still be met if the combination of the undergraduate courses and the master’s courses taken at OAU by each student totals at least 45 semester hours of course work in engineering topics.

It is possible that the requirement for a major design experience was satisfied by admitted students during an undergraduate engineering program, but this is not verified during the admission process, and students without an undergraduate engineering degree will likely not have completed an appropriate major design experience. Furthermore, it would be almost impossible to verify this requirement without examining the design project of each admitted student. Therefore, it seems that the best way to ensure compliance with the requirement would be to require each student to complete an appropriate engineering design project during the master’s program work. There have been no master’s theses completed yet in the programs, so it was not possible to determine whether the thesis work could qualify as an appropriate engineering design project satisfying the ABET EAC requirements. The BS in Computer Engineering projects that were examined were basically good design experiences but lacked some formal ABET EAC requirements such as explicitly addressing multiple realistic constraints and appropriate engineering standards.

**Recommendations:**

4. A process must be established to ensure that all students who graduate from each master’s program have completed work that supports attainment of each of the Criterion 3 outcomes of the ABET EAC undergraduate general criteria.

5. A process must be established to ensure that each graduate of the programs has completed at least 30 semester hours of mathematics and basic science, and at least 45 semester hours of engineering topics, during the student’s undergraduate
and graduate course work.

6. A process must be established to ensure that each graduate of the programs has completed a major design experience that satisfies the major design experience requirement of ABET EAC General Criterion 5 for undergraduate programs.

Criterion statement (part 2):
The master’s level engineering program must have and enforce policies and procedures ensuring that a program of study with specific educational goals is developed for each student. Student performance and progress toward completion of their programs of study must be monitored and evaluated. The program must have and enforce procedures to ensure and document that students who graduate meet all graduation requirements.

The master’s level engineering program must require each student to demonstrate a mastery of a specific field of study or area of professional practice consistent with the master’s program name and at a level beyond the minimum requirements of baccalaureate level programs.

The master’s level engineering program of study must require the completion of at least 30 semester hours (or equivalent) beyond the baccalaureate program.

Program analysis for part 2:
The programs appear to satisfy the requirements of Part 2 of the criterion.

Criterion statement (part 3):
Each student’s overall program of post-secondary study must satisfy the curricular components of the baccalaureate level program criteria relevant to the master’s level program name.

Curriculum requirements from the Program Criteria for Computer Engineering programs:
The structure of the curriculum must provide both breadth and depth across the range of engineering topics implied by the title of the program.
The curriculum must include probability and statistics, including applications appropriate to the program name; mathematics through differential and integral calculus; sciences (defined as biological, chemical, or physical science); and engineering topics (including computing science) necessary to analyze and design complex electrical and electronic devices, software, and systems containing hardware and software components.
The curriculum for programs containing the modifier “computer” in the title must include discrete mathematics.

Curriculum requirements from the Program Criteria for Software Engineering programs:
The curriculum must provide both breadth and depth across the range of engineering and computer science topics implied by the title and objectives of the program.
The curriculum must include computing fundamentals, software design and construction, requirements analysis, security, verification, and validation; software engineering processes and
tools appropriate for the development of complex software systems; and discrete mathematics, probability, and statistics, with applications appropriate to software engineering.

Program analysis for part 3:

Note that currently there are no ABET EAC program criteria for Intelligent System Engineering, so the Part 3 requirements would not apply to that program. It appears likely that the Computer Engineering and Software Engineering programs meet the relevant requirements from the EAC Program Criteria associated with each program. However, the explicit inclusion of discrete mathematics in the appropriate required course’s course description should be added. Also for Software Engineering, the explicit course(s) satisfying the requirement for addressing “...probability, and statistics, with applications appropriate to software engineering” should be noted.

Recommendation:

7. Ensure that each student who graduates from the Computer Engineering program and the Software Engineering program has the preparation specified in the ABET EAC Program Criteria for the program.

Criterion: Program Quality

Criterion statement:
The master’s level engineering program must have a documented and operational process for assessing, maintaining and enhancing the quality of the program.

Program analysis:

It appears that currently there is no documented formal process for assessing, maintaining, and enhancing the quality of the program. The use of the NUC reviews does represent an appropriate quality assurance process relative to the requirements of the Program Quality Criterion, but the process needs to be formalized and documented, as opposed to being essentially ad hoc. However, the NUC review is appropriately a general review process that is used for all programs, and does not focus on specific intended outcomes for individual programs. There also is a Curriculum Review Committee that is formed every five years to review each program’s curriculum and propose modifications.

The members of an ABET review team, who mostly perform accreditation evaluations for undergraduate programs, would be used to seeing a formal assessment of the extent to which students attain the student outcomes for the program, as is required by the ABET accreditation criteria for undergraduate programs. Although a formal assessment of student outcome attainment is not explicitly required by the EAC
master’s-level criteria, it is advisable to implement a formal process for reviewing whether students are attaining the student outcomes at an acceptable level. Such a process would provide more complete evidence of having quality assurance processes that satisfy the intent of the Program Quality Criterion. This might be done, for example, by having the faculty review the performance of each cohort relative to each outcome near the time of graduation, and to identify any need for program improvement to address student attainment that is below expectations for each outcome. It might also be feasible to administer the Nigerian engineering licensing examination to all graduating students and compare the results to a targeted performance level as a basis for evaluating whether the program is meeting its intended outcomes.

Recommendations:

8. A documented and operational process for assessing, maintaining, and enhancing the quality of the program must be established.

9. A formal process should be implemented for reviewing the extent to which students are attaining the program’s student outcomes at an acceptable level.

**Criterion: Faculty**

Criterion statement:
The master’s level engineering program must demonstrate that the faculty members are of sufficient number and that they have the competencies to cover all of the curricular areas of the program. Faculty teaching graduate level courses must have appropriate educational qualifications by education or experience. The program must have sufficient faculty to accommodate adequate levels of student-faculty interaction, student advising and counseling, university service activities, professional development, and interactions with industrial and professional practitioners, as well as employers of students.

The master’s level engineering program faculty must have appropriate qualifications and must have and demonstrate sufficient authority to ensure the proper guidance of the program. The overall competence of the faculty may be judged by such factors as education, diversity of backgrounds, engineering experience, teaching effectiveness and experience, ability to communicate, level of scholarship, participation in professional societies, and licensure.

Program analysis:

The faculty appears to be solid. All faculty members have PhDs and some publications. There is good engagement in professional societies and involvement with industry in the Lagos area. Care should be taken to avoid hiring new faculty members with a recent PhD from OAU. It is understandable that it is difficult to attract faculty from
other regions to Ille-Ife, but PhD graduates from OAU should gain sufficient academic experience or industrial experience elsewhere before joining the OAU faculty. Finally, all three programs need to have established and well engaged external advisory boards, or one board for all three programs. This will benefit the programs, the students, and industry in the long run. Professional development should be strongly encouraged and supported among all faculty, especially those new to the staff.

Recommendation:

10. The programs should have an external advisory board consisting of potential employers of graduates, other representatives from computing-related industries, and graduates of the programs.

**Criterion: Facilities**

Criterion statement:
Means of communication with students, and student access to laboratory and other facilities, must be adequate to support student success in the program, and to provide an atmosphere conducive to learning. These resources and facilities must be representative of current professional practice in the discipline. Students must have access to appropriate training regarding the use of the resources available to them.

The library and information services, computing and laboratory infrastructure, and equipment and supplies must be available and adequate to support the education of the students and the scholarly and professional activities of the faculty.

Remote or virtual access to laboratories and other resources may be employed in place of physical access when such access enables accomplishment of the program’s educational activities.

Program analysis:

The classroom and office space for the program are good, and additional facilities are under construction with funds from external sources. The additional facilities will be needed as the graduate programs grow.

**Criterion: Institutional Support**

Criterion statement:
Institutional support and leadership must be adequate to ensure the quality and continuity of the program. Resources including institutional services, financial support, and staff (both administrative and technical) provided to the program must be adequate to meet program needs. The resources available to the program must be sufficient to attract, retain, and provide for the
continued professional development of a qualified faculty. The resources available to the program must be sufficient to acquire, maintain, and operate infrastructure, facilities, and equipment appropriate for the program, and to provide an environment in which student learning outcomes can be attained.

Program analysis:

In general, the institutional leadership has been successful in providing adequate support to meet the needs of the programs. However, current funding for operating and improving the programs relies on obtaining donations and grants from various sources. The continuation of all such funding is not ensured, and it appears that the university may be unable to provide the needed funding without the external donations and grants.

Recommendations:

11. Efforts to provide a more stable funding base for support of the programs should be made.

Program Analysis Relative to ABET Policies and Procedures

Although the majority of the requirements for accreditation are described in the EAC Criteria document, there are several important requirements covered in the ABET Policy and Procedures Manual (APPM) that apply to all programs. The APPM requirements are not accreditation criteria as such, but not having them satisfied can have the same impact on a program’s accreditation as would an issue with an item in the EAC Criteria document.

The entire APPM document should be reviewed to appreciate the scope of the accreditation process, but the following items are of special note since members of an ABET review team will certainly be looking for them in their evaluation of the program.

- I.E.5.b.(1) [The review team will examine:] Facilities - to assure the instructional and learning environments are adequate and are safe for the intended purposes.
- I.A.6.a. Each ABET-accredited program must publicly state the program’s educational objectives (PEOs) and student outcomes (SOs).
- I.A.6.b. Each ABET-accredited program must publicly post annual student enrollment and graduation data specific to the program.

Program analysis:
No safety problems were observed in the current facilities, but extensive new facilities are under construction and care must be taken to ensure that appropriate safety features are included. It appears that currently there is no public publication of the information for the program that is required in the APPM.

**Recommendations:**

12. Appropriate safety measures must be implemented in the new facilities.

13. The programs’ educational objectives, student outcomes, student enrollment data, and graduation data must be published, preferably on the programs’ web site.

**Summary of Program Analysis**

In general, the M.Sc. programs in Computer Engineering, Intelligent System Engineering, and Software Engineering produce graduates who are well prepared to contribute to the need for advanced computing professionals in Africa. The programs have good support from the industry and from other sources.

However, several modifications are needed to bring the programs into compliance with the ABET EAC criteria for accreditation if the university wishes to pursue ABET accreditation for the programs. These actions are detailed above in the analysis for each requirement for accreditation, and summarized in the recommendations that are listed below. Some of the necessary actions to bring the program into compliance with the accreditation requirements are easy to implement, but others will require significant time and effort to plan and implement.

**Summary of all recommendations**

1. The programs must adopt a set of PEOs that conform to the ABET definition.

2. A process for periodically reviewing whether the PEOs meet the needs of the program constituencies (employers and graduates) should be implemented.

3. Adopt additional student outcomes for each of the three programs.

4. A process must be established to ensure that all students who graduate from each master’s program have completed work that supports attainment of each of the Criterion 3 outcomes of the ABET EAC undergraduate general criteria.

5. A process must be established to ensure that each graduate of the programs has completed at least 30 semester hours of mathematics and basic science, and at
least 45 semester hours of engineering topics, during the student’s undergraduate and graduate course work.

6. A process must be established to ensure that each graduate of the programs has completed a major design experience that satisfies the major design experience requirement of ABET EAC General Criterion 5 for undergraduate programs.

7. Ensure that each student who graduates from the Computer Engineering program and the Software Engineering program has the preparation specified in the ABET EAC Program Criteria for the program.

8. A documented and operational process for assessing, maintaining, and enhancing the quality of the program must be established.

9. A formal process should be implemented for reviewing the extent to which students are attaining the program’s student outcomes at an acceptable level.

10. The programs should have an external advisory board consisting of potential employers of graduates, other representatives from computing-related industries, and graduates of the program.

11. Efforts to provide a more stable funding base for support of the programs should be made.

12. Appropriate safety measures must be implemented in the new facilities.

13. The programs’ educational objectives, student outcomes, student enrollment data, and graduation data must be published, preferably on the programs’ web site.

Additional comments and observations

It should be noted that any decision as to whether to accept a request for evaluation submitted to ABET is ABET’s alone, and there is no guarantee that ABET will accept such a request and send an evaluation team to Nigeria. Such decisions are based on safety and health conditions at the time, and on the recommendations of relevant governments and the safety and health services company retained by ABET. Whether or not a university has undertaken a consultant review and made efforts to bring its program into compliance with the relevant ABET criteria is not a consideration in such a decision. If there is interest in pursuing ABET accreditation, a university official should contact ABET to investigate the possibility of an ABET review. ABET may be willing to review programs in some locations but not in others, and a decision as to whether to accept a request is made for each individual institution and not necessarily for a country as a whole.
If the university should decide to request an evaluation for possible accreditation by the ABET EAC, a preliminary review (“Readiness Review”) will be required by ABET. For a Readiness Review, a preliminary self study, fairly complete in the criteria sections and as complete as reasonable in the appendices, must be submitted to ABET by October 1 of the year prior to the year when an evaluation review visit by the ABET EAC is desired. The submitted self study receives an initial high-level review that results in a recommendation as to whether the university should proceed to submit a request for a full review. The self study that is submitted for a Readiness Review can be extensively modified as needed before submission to ABET by July 1 prior to the fall visit by an ABET EAC evaluation team.

It is especially beneficial for a program undergoing an ABET review for initial accreditation to have consultation from one or more experts in ABET accreditation before submitting a self study to ABET. Such consultation can take the form of an onsite visit by the consultant(s) or only a review of a draft self study by a consultant before submission to ABET.

**Work plan to implement needed actions**

In planning to implement the recommendations of this report, it should be noted that any changes in the curriculum and student projects that are needed must be implemented prior to an accreditation review by the ABET EAC. The most recent graduates of the program before an accreditation decision is made by the EAC must have completed a program that satisfies all requirements of the criteria. It is preferable and recommended that the most recent graduates prior to an ABET review visit have completed such a program.