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New Curriculum Development for a top African University

Abstract

A new curriculum is being developed for undergraduate education in a Department of Electronic and Electrical Engineering for one of the top universities in Africa. The old curriculum is many years old and needs to be re-vamped. I was invited to be a member of a committee selected to help provide input and advice for the university. The committee has re-vamped the curriculum and made drastic changes to it to meet current needs.

In this paper, we provide information about the old and new curriculum. We also specify the new themes we identified for inclusion in the new curriculum development process. This is a great example of curriculum development issues that need to be tackled for most universities in developing countries.

Later, we discuss the needs required to implement the new curriculum.

Part of the issues are based on the fact that these universities have to do with less in terms of having the financial support and the means required to provide state-of-art equipment for teaching and research in Electronic and Electrical Engineering.

We focus on the need to develop a sizable amount of endowment to help the university offset some of the costs of procuring and maintaining equipment for teaching and research.
We discuss other challenges such as recruiting new faculty and finding expertise to teach some of the new courses in the curriculum and suggest some possible solutions.

Introduction

The University of Ife was founded in 1962 (the second university in Nigeria) just two years after Nigeria gained independence from Britain in 1960. It was re-named Obafemi Awolowo University in 1987 in honor of one of its most distinguished founding fathers and eminent Nigerian nationalist, politician, lawyer statesman and former Chancellor, Chief Jeremiah Obafemi Awolowo.

The university has granted degrees to about 75,000 alums since its inception. The degrees are in diverse fields such as Medicine. Pharmacy, Engineering, Science, Arts, Law, Business, Administration, Education, Dentistry, etc. The alumni are all over the world contributing to society in their sphere of influence.

Currently the university has about 25,000 students enrolled pursuing degrees in 13 Colleges and about 70 departments. The campus claims to be the most beautiful campus in Africa. There are striking beautiful architectures, landscaping and buildings. The university is also one of the largest with some 4000 acres of land, most of it yet undeveloped. Currently OAU has about 7,000 faculty and staff and about 5,000 visitors everyday. You can also explore the university website http://www.oauife.edu.ng [1].

The School (Faculty) of Technology has 9 Departments: Electronic and Electrical Engineering, Agricultural Engineering, Chemical Engineering, Food Science and Technology, Mechanical Engineering, Computer Science and Engineering, Civil Engineering, Materials Science and Engineering and Technology Planning and Development Unit (TPDU).
All the departments (except TPDU) offer undergraduate degrees. Many departments also offer graduate degrees (MS, MPhil and PhD) in their fields.

This paper focuses on the development of a new BS curriculum for the Department of Electronic and Electrical Engineering. We also discuss some unique challenges of an engineering school in a developing country.

The Old BSEEE Curriculum at OAU

The original BSEEE curriculum was introduced at the beginning of the program. This curriculum was patterned after British educational system. Courses are offered for the entire academic year. Typically, there are some homework but no exams until the last week of classes. The final exam is comprehensive and covered all the year's material. It accounted for 100 % of the students ' overall course grade.

A new curriculum introduced in the late 1970's was patterned after US universities. It was based on a semester academic year system. Courses are offered every semester. Grades are based on continuous cumulative evaluation using homework, quizzes, midterm exams and a final exam. The first set of students were admitted in 1975 to use the second BSEEE curriculum which had just been adopted to supersede the old first curriculum of the 1960's and early 1970's.

Comparing the two different curricula, it is clear that students learned the material better because of continuous testing. It was more work for the students and more difficult to meet the high standard of academic excellence demanded by this new system. However, I believe this system is better suited to student understanding and learning.

Now, we describe the second curriculum which was adopted in 1975 and used until now.

BSEEE Program Objectives

The undergraduate program is designed to produce graduates that can be more readily absorbed into the various areas of the rapidly developing field of Electronic and Electrical Engineering. Students are exposed to both basic and applied courses as well as laboratory and industrial training to enable them satisfy the manpower needs of the public and industrial sectors of the Nigerian economy. The graduates are expected to be able to design and supervise Engineering projects and construction, develop new products and techniques as well as maintain Engineering Units. The program also offers sufficient depth to enable the promising graduates to undertake postgraduate work in Electronic and Electrical Engineering or related disciplines in Science Engineering.

The program is organized such that two years of basic training in Electronic and Electrical Engineering Science is followed by more detailed professional training in the field of Electronic and Electrical Engineering lasting for two years. In the final year, students are given the options to specialize in any of the following areas:

i. Communication Engineering
ii. Control Engineering and Instrumentation
iii. Electronic Materials and Devices Technology
iv. Electrical Machines
v. High Voltage Engineering

BSEEE Graduation Requirements

To be eligible for the degree of BSc. in Electronic and Electrical Engineering (BSEEE), a candidate must, satisfactorily complete a minimum of 202 units including:

i. 12 units of Special Electives
ii. 31 units of Part I Physics, Chemistry and Mathematics courses.
iii. 89 units of Electronic and Electrical Engineering courses excluding 'Industrial' Training.
iv. 4 units of Agricultural Engineering courses, comprising AGE 202 and AGE 302.
v. 8 units of Chemical Engineering courses comprising CHE 201, CHE 305 and CHE 306.
vi. 4 units of Civil Engineering courses comprising CVE 202 and CVE 401.
vii. 5 units of Computer Science courses comprising CSC 201 and CSC 208.
viii. 8 units of Mathematics courses comprising MTH 201 and MTH 202.
ix. 9 units of Mechanical Engineering courses comprising MEE 203, MEE 204 MEE 205 and MEE 206.
x. 2 units of Materials Science and Engineering courses comprising MME 201.

xi. 7 units of Technology Policy and Planning courses comprising TPD 202, TPD 501, TPD 502 and TPD 503
xii. 15 units of Industrial Training courses comprising EEE 200, EEE 300 and EEE 400.

The year-by-year breakdown of courses are as follows:
Year 1 = 45 units (Basic Math and Sciences)
Year 2 = 41 units
Year 3 = 42 units
Year 4 = 31 units plus 6-month Industrial Training
Year 5 = 43 units
Total = 202 units

The Need for a new BSEEE Curriculum at OAU

There is a need for a new curriculum. The old one needs to be modified and re-vamped. The BSEEE curriculum had been in place since the freshman class of students admitted in 1975. Meanwhile the field of electrical engineering has grown by leaps and bounds and there have been myriads of new technologies introduced since then. Examples are Computer Communications, the Internet, Deep Space exploration, Nanotechnology, Medical and biological devices, energy systems, signals and information processing systems, etc.
To keep pace with the explosive growth in the field and the new engineering educational delivery [2, 3, 4, 5] methods (internet, video streaming, iLab, etc.), there is a real need to develop a new BSEEE curriculum.

The Proposed BSEEE Curriculum at OAU

The guiding principles for developing the new curriculum are discussed below:

The proposed curriculum introduces students to all levels of abstractions on which analysis and synthesis of electrical, electronic, computer and information systems are based and provide students the capability to use the abstractions to analyze, design and innovate complex electrical, electronic, computer and information systems.

The objective is to provide skills for the student to be able to navigate through the following levels of abstraction/conceptualization that are prevalent in today's energy, signals and computer and information systems. These are (a) materials (semiconductor), (b) electronic devices, (c) lumped circuit elements, (d) amplifiers, (e) digital signals, (f) combinational logic, (g) clocked digital (sequential logic), (h) instruction set (architecture), (i) programming language (software). In addition to the linear chain presented above for digital systems the students will become versatile with the following analog systems abstractions: operational amplifier, filters and analog system components which more often than not are now implemented digitally. The abstractions for electrical machines, power generation and transmission, though not explicitly stated are already embedded in (b), (c) and (d).

The first year will remain the same. The students take the Basic Sciences of Chemistry, Physics, Mathematics and other university-required courses. This will prepare them for all the fields of engineering represented by all the engineering departments. The second to the fifth years are divided into three groups as follows:

First group of classes: Survey classes introducing students to all the level of abstractions outlined above to be taken in the second year. These are

1. Programming Structures (CSE course)
2. Electrical and Electronic Circuits (EEE 201 & EEE 202)
3. Digital and Computation Structures (EEE 305a & EEE 305b)
4. Signals and Systems (EEE 306)

Second Group of Classes: This is the third year where they take classes that introduce the key abstractions in depth. These classes bring into engineering the basic sciences (physics, chemistry and biology) and mathematics that are required for further analysis and design of energy, signals and information processing systems.

1. Introduction to Communications, Control and Signal Processing (EEE 3XX or EEE 4XX)
2. Introduction to Microelectronics (EEE 301 & EEE 302)
3. Introduction to Electromagnetics (EEE 311)
4. Introduction to Computer Architecture (CSE course)

A fourth course - Introduction to Computer Architecture was added. It was suggested that students take three of the four courses. There was a thought to add a fifth class to this group that is an introduction to Electrical Power Generation, Transmission and machines. Alternatively, the Introduction to Electromagnetic theory serves this purpose and if necessary could be expanded into two semesters.

Third Group of Classes (Specializations): The third set of courses are the specialist classes which are given in fourth and fifth years.

1. Semiconductor Devices (course exists)
2. Analog Circuits (course exists)
3. Digital Circuits (course exists)
4. Embedded System Design (proposed)
5. Electromagnetic Waves (course exists)
6. Lasers (proposed)
7. Power Systems (Generation and Distribution) (course exists)
8. Electrical Motors and Generators (course exists)
9. Information Theory (proposed)
10. Digital Communications (course exists)
11. Feedback and Control Systems (course exists)
12. Linear Systems (proposed)
13. Signal Processing (proposed)
14. Image Processing (proposed)
15. Wireless Communications (proposed)

16. Fiber-optic communications (proposed)
17. Microcontroller Systems Design (proposed)

The list could be endless and they are all based on solid foundation from the first two groups of courses.

An outline of the newly proposed curriculum is displayed in the Tables below:
Year 1 is the first year when the students take the basic science courses: Physics, Chemistry, Mathematics and other university requirements and is not shown here.

Each year consist of two semesters: harmattan semester and rain semester.

The rain semester of Year 4 plus the summer (a 6-month period total) is designed to give the students first hand industrial experience by working in a company outside the campus.
All the courses taken in the fifth year are electives to give the students a chance to specialize and get more in-depth knowledge in a sub-discipline of the electronic and electrical engineering field.

DEPARTMENT OF ELECTRONIC AND ELECTRICAL ENGINEERING
PROPOSED UNDERGRADUATE CURRICULUM

YEAR 2

Harmattan Semester				
Course Code	**Course Title**	**Units**	**Prerequisite**	**Remarks**
EEE 201	Fundamentals of Electronic &Electrical Engineering I	4	PHY 101 & 102	Modified
EEE 291	Fundamentals of Electronic &Electrical Engineering Lab I			Introduce iLab experiments in addition to regular experiments
MME201	Engineering Materials	3		Outside Course
CHE 201	Introduction to Thermodynamics	3		Outside Course
CSC 201	Computer Programming I	3		Outside Course
MTH201	Mathematical Methods I	4	MTH 102	Outside Course
MEE 205	Engineering Mechanics I	3		Outside Course
TOTAL UNITS		20		
Rain Semester				
EEE 202	Fundamentals of Electronic &Electrical Engineering II	4	EEE 201	Modified
EEE 292	Fundamentals of Electronic &Electrical Engineering Lab II		EEE 291	Introduce iLab experiments in addition to regular experiments
AGE 202	Workshop Practice	2		Outside course
EEE 204	Electrical/Electronic Materials	2	EEE 201	To replace outside course
MEE 204	Engineering Drawing	3		Merge MEE 203 & MEE 204 for 3 units
MEE 206	Engineering Mechanics II	3	MEE 204	Outside Course
MTH 202	Mathematical Methods II	4	MTH 201	Outside Course

TOTAL UNITS		18		

LONG VACATION

Course Code	Course Title	Units	Prerequisite	
EEE 200	**Student Work Experience**	3		

YEAR 3

Harmattan Semester				
Course Code	**Course Title**	**Units**	**Prerequisite**	**Remarks**
EEE 301	Microelectronic Devices and Circuits I	3	EEE 206	Formerly EEE 302 and Modified
EEE 303	Electromechanical Devices	3	EEE 202	Modified and change in course title
EEE 305a	Computation Structures I	3	EEE 202	Now 3 units instead of 4
EEE 307	Electrotechnics Lab I	2	EEE 202	No Change
EEE 309	Group Design I	1	EEE 202 & EEE 206	New Course
EEE 311	Electromagnetic Theory	3	EEE 202	Modified to replace EEE311 and EEE312 Now 3 units instead of 4
EEE 306	Signals & Systems	3	EEE 202	New Course
CHE 305	Engineering Mathematics I	3	MTH 202	Outside course
TOTAL UNITS		**20**		

Rain Semester				
Course Code	**Course Title**	**Units**	**Prerequisite**	**Remarks**
EEE 302	Microelectronic Devices and Circuits II	2	EEE301	Modified to replace EEE 309
EEE 304	Electrical Machines	3	EEE 303	No Modification
EEE 305b	Computation Structures II	3	EEE 305a2	New
EEE 308	Electrotechnics Lab II	2	EEE 307	No Modification
EEE 310	Digital Circuit Design	3	EEE 301	Modified
EEE 313	Measurements and Instrumentation I	3	EEE 202	Modified Content
EEE 312	Group Design I	1	EEE 202 & EEE 206	New Course
CHE 306	Engineering Mathematics II	3	CHE 305	Outside course
AGE 302	Statistics for Engineers	2		Outside course
TOTAL UNITS		**19**		

LONG VACATION

Course Code	Course Title	Units	Prerequisite	
EEE 300	**Student Industrial Work Experience Scheme I**	3	EEE 200	

YEAR 4

Harmattan Semester				
Course Code	**Course Title**	**Units**	**Prerequisite**	**Remarks**
EEE 401	Numerical and Computational Methods	2	CHE 306	Modified Content
EEE 403	Electric Power Principles	3	EEE 304	Modified content
EEE 405	Electrical Engineering Laboratory	2		No modification
EEE 407	Group Design II	1	EEE 312	New course
EEE 409	Analog Circuit Design	3	EEE 301	Change in title and content modified
EEE 411	Introduction to Controls, Communications & Signal Processing	4	EEE 306	Change in title and content modified
EEE 413	Communication Principles	3	EEE 306	content modified
EEE 415	Semiconductor Devices	3	EEE 301	content modified
CVE 401	Technical Report Writing	2		Outside course
TOTAL UNITS		**22**		

LONG VACATION

Course Code	Course Title	Units	Prerequisite	
EEE 400	**Student Industrial Work Experience Scheme II**	9	EEE 300	

YEAR 5

Harmattan Semester				
Course Code	**Course Title**	**Units**	**Prerequisite**	**Remarks**
EEE 501	Independent Project I	3		
EEE 503	Control Engineering I	3	EEE 411	content modified
EEE 505	Applications of Electromagnetic Principles	3	EEE 311	content modified
EEE 507	Measurement & Instrumentation II	3	EEE 313	content modified
TPD 501	Industrial Economics and Management	2		Outside course
DEPARTMENTAL ELECTIVES Candidates are expected to register for a minimum of two three-unit courses from following courses				
Communication Option				
EEE 511	Wireless Communication	3	EEE 411	New course
EEE 513	Communications Theory	3	EEE 411	Formerly EEE 509 Modified content
Instrumentation & Control Option				
EEE 517	Introduction to Modern Control	3	EEE 409	Formerly EEE515 Modified content
EEE 519	Instrumentation Engineering	3	EEE 313	Formerly EEE 521 Modified content
Power and Machine Option				

EEE 523	Power Devices and Circuits	3	EEE 301	Formerly EEE 513 Modified content
EEE 525	High Voltage Engineering	3	EEE 403	Formerly EEE 517
EEE 527	Power Systems Engineering I	3	EEE 403	Formerly EEE 519 Modified content
Solid State Option				
EEE 529	Micro- and Nano-electronics Device Proccesing	3	EEE 413	Modified content
EEE 531	Optical Electronics	3	EEE 413	Formerly EEE 525 Modified content
TOTAL UNITS		**20**		

YEAR 5 Rain Semester				
Course Code	**Course Title**	**Units**	**Prerequisite**	**Remarks**
EEE 502	Independent Project II	3	EEE 501	
EEE 504	Digital Signal Processing	3	EEE 306	
EEE 506	Electrical Services & Energy Utilization	3	EEE 403	
EEE 508	Reliability & Maintainability of Elect/Elect Systems	2		
TPD 502	Industrial Law and Technology Policy	2		Outside course
DEPARTMENTAL ELECTIVES Candidates are expected to register for a minimum of two three-unit courses from following courses				
Communication Option				
EEE 512	Radio Frequency Electronics	3	EEE 513	
EEE 514	Telecommunications Engineering	3	EEE 513	
EEE 516	Computer Communications	3	EEE 513	Formerly EEE 530 Modified content
Instrumentation & Control Option				
EEE 518	Control Engineering II	3	EEE 517	Formerly EEE 516 Modified content
EEE 520	Modelling & Simulation of Dynamic Systems	3	EEE 517	Formerly EEE 518 Modified content
EEE 522	Intelligent Control	3	EEE 517	New Course
Power and Machine Option				
EEE 518	Control Engineering II	3	EEE 517	Formerly EEE 516 Modified content
EEE 528	Power Systems Engineering II	3	EEE 527	Formerly EEE 522 Modified content
Solid State Option				
TOTAL UNITS		**19**		

It is clear that the new requirements are different from the old requirements. The philosophy of the course outlines is different. The learning objectives and goals are also new and different.

We have introduced several new courses and modified several existing ones.
We also propose using new teaching methods such as Group Study approach and Project-Based Approach to help student learning.

There are many challenges to implementing our proposals. One of them is ability to provide laboratory equipment and design laboratory experiments for the new and some existing courses. To be able to help meet this need, we propose using available tools such as MIT's iLab, etc. In addition, we also have availability of MIT Open Courseware which can be downloaded free online and has grown to be a useful tool for many universities in many developing countries. A necessity (or requirement) for using these tools is the availability of broadband internet connection which is not so common for many developing countries.
However, the OAU has made provision of campus-wide free Internet connection a priority.

Implementation Challenges for the Proposed BSEEE Curriculum at OAU

As mentioned above, implementing a new curriculum such as was proposed requires sufficient financial and institutional support. Part of the issues are based on the fact that these universities have to do with less in terms of having the financial support and the means required to provide state-of-art equipment for teaching and research in Electronic and Electrical Engineering.

There is a need to develop a sizable amount of endowment to help the university offset some of the costs of procuring and maintaining equipment for teaching and research.

OAU Alumni worldwide are trying to help out by contributing to endowment funds. See the web site http://www.greatifealumni.org/2008reunion/index.asp [6] for details of typical alumni fund-raising activities for the university endowment. The university has also opened an alumni office to keep track and contact with all alumni worldwide. In addition, the alumni have indicated willingness to give occasional or weekend classes.

There are other challenges such as recruiting new faculty and finding expertise to teach some of the new courses in the curriculum and suggest some possible solutions.

A final note here is the importance of the university setting up process of monitoring the quality of the graduates using the new curriculum. Then the question of whether the new curriculum is meeting the new challenges of educating a new generation of engineers for the unique problems and solutions of engineering for the 21st century can be answered.

Conclusions

In this paper, we presented a new curriculum for undergraduate education in a developing country. We provided information about the old and new curriculum. We also specified the new themes we identified for inclusion in the new curriculum development process. Then, we discussed the needs required to implement the new curriculum.

Some of the issues are based on the fact that these universities have to do with less in terms of having the financial support and the means required to provide state-of-art equipment for teaching and research in Electronic and Electrical Engineering.

Finally, we discussed challenges for implementing the new curriculum. We mentioned the need to develop a sizable amount of endowment to help the university offset some of the costs of procuring and maintaining equipment for teaching and research.
We discussed other challenges such as recruiting new faculty and finding expertise to teach some of the new courses in the curriculum and suggest some possible solutions.

We hope this paper makes a great case study of curriculum development issues that need to be tackled for most universities in developing countries.

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