Crafting a 21st Century Undergraduate Engineering Programme for Sub-Saharan Africa

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Ashesi University College
Ghana, West Africa
Ethical Leadership
Innovative Thinking
A New Africa

Africa Needs:
• Effective Teams
• Innovation
• Tenacious Leaders
To cultivate within our students the critical thinking skills, the concern for others, and the courage it will take to transform their continent.

To educate a new generation of ethical, entrepreneurial leaders in Africa.
Academic Programmes

- Computer Science
  - Management Information Systems
- Business Administration
- Engineering
  - Computer
  - Electrical & Electronic
  - Mechanical

Liberal Arts Core: Social Sciences, Humanities, Mathematics, African Studies and Leadership
Development of Engineering Programme

- John E. Fetzer Institute Funding - Spring 2014
  - Love, Compassion, Forgiveness
- Initial working document complete - Spring 2014
- Sent to local and international engineering educators - May 2014
  - Olin Summer Collaboratory – June 2014
- Presented to Industry Stakeholder’s Meeting - August 2014
Development of Engineering Programme

- International Engineering Advisory Committee meeting in U.S. – September 2014
- UMaT affiliation agreement – October 2014
- Application to National Accreditation Board (NAB) of Ghana – December 2014
- NAB Panel Visits – February 2015
In your opinion, how important are the following in an undergraduate engineering education? Please rate each on a scale of 5: very important to 1: not important.

<table>
<thead>
<tr>
<th>Importance</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>91%</td>
<td>Communication</td>
</tr>
<tr>
<td>91%</td>
<td>Design thinking</td>
</tr>
<tr>
<td>91%</td>
<td>Integrity / ethics</td>
</tr>
<tr>
<td>91%</td>
<td>Systems thinking</td>
</tr>
<tr>
<td>88%</td>
<td>Real world projects in a local context</td>
</tr>
<tr>
<td>88%</td>
<td>Teamwork</td>
</tr>
<tr>
<td>84%</td>
<td>Continuous assessment of graded work</td>
</tr>
<tr>
<td>71%</td>
<td>Strong general engineering coursework</td>
</tr>
<tr>
<td>68%</td>
<td>Varied courses in the engineering discipline</td>
</tr>
<tr>
<td>65%</td>
<td>Computer programming</td>
</tr>
<tr>
<td>23%</td>
<td>Fluency in the French language</td>
</tr>
</tbody>
</table>
When you are looking at a recent engineering university graduate’s C.V., how important are the following? Please rate each on a scale of 5: very important to 1: not important.

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>91%</td>
<td>Projects / practical work</td>
</tr>
<tr>
<td>85%</td>
<td>Quality of engineering programme</td>
</tr>
<tr>
<td>73%</td>
<td>Internship experiences</td>
</tr>
<tr>
<td>70%</td>
<td>Practical skills with machines, computers</td>
</tr>
<tr>
<td>63%</td>
<td>Particular courses taken</td>
</tr>
<tr>
<td>43%</td>
<td>Student organization leadership experience</td>
</tr>
<tr>
<td>43%</td>
<td>Graduation honours</td>
</tr>
<tr>
<td>40%</td>
<td>Community service / engagement</td>
</tr>
<tr>
<td>38%</td>
<td>Course grades</td>
</tr>
<tr>
<td>31%</td>
<td>Prestige of University</td>
</tr>
<tr>
<td>25%</td>
<td>Travel or international experience</td>
</tr>
<tr>
<td>20%</td>
<td>Fluency in multiple spoken languages</td>
</tr>
</tbody>
</table>
Gaps in Engineering Graduates’ Skills and Knowledge

• Critical thinking, general problem solving
• Social skills
• (Gender &) diversity issues
• Writing and communication
• General professional skills, work ethic, and ethics in general
• System-level thinking and planning a system from design through maintenance
• Environmental issues, health & safety issues
• Knowledge of and experience with instrumentation and experimentation
Engineering at Ashesi: Core Strengths

Goal: Educate tinkerers who will create engineering solutions for local needs

- Design & Entrepreneurship
- Hands-on projects
- Real world experience via monitored projects and internships
- Commitment to gender balance
- 300 students, 1/3 of student population
### Ashesi’s Engineering Programme

<table>
<thead>
<tr>
<th>Course</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Engineering</td>
<td>20%</td>
</tr>
<tr>
<td>Electrical and Electronic Engineering</td>
<td>20%</td>
</tr>
<tr>
<td>Mechanical Engineering</td>
<td>40%</td>
</tr>
<tr>
<td>Foundational (Technical) Courses</td>
<td>15%</td>
</tr>
<tr>
<td>Liberal Arts Core</td>
<td>20%</td>
</tr>
</tbody>
</table>

*Note: The diagram illustrates the distribution of courses across different domains within the engineering programme.*
Liberal Arts

Essential Skills
- Giving Voice to Values
- Written & Oral Communication
- Leadership Seminars 1-3
- Design & Entrepreneurship 1-2

Breadth and Critical Thinking
- Text & Meaning
- Social Theory
- African Studies
- Economics
Foundational Courses

• Calculus 1 & 2
• Statistics for Engineering
• Computer Programming
• Leadership Seminar 4 + Third Year Service Learning Project
Engineering Core

Math & Science
- Physics: Mechanics
- Physics: Electromagnetism
- Material Science & Chemistry
- Multivariable Calculus & Linear Algebra
- Differential Equations & Numerical Methods
- Applied Programming for Engineers

Engineering
- Introduction to Engineering
- Circuits & Electronics
- Instrumentation for Engineering
- System Dynamics
- Control Systems
- Digital Electronics & Computer Systems
- Project Management & Professional Practice
- Senior Project 1 & 2
5 Required Disciplinary Courses

Plus 2 Disciplinary Electives

Computer

• Data Structures & Algorithms
• Operating Systems
• Networks & Distr. Computing

Electrical & Electronic

• Communication Systems
• Embedded Systems
• Advanced Electrical Machines & Power Electronics

Mechanical

• Intro to Electrical Machines & Power Electronics
• Fundamentals of Thermal Fluid Science & Heat Transfer
• Mechanics of Materials / Structural Engineering
• Mechanical Machine Design
• Thermal Systems & Applications
Engineering Electives

- Environmental Engineering
- Robotics
- Some Business and Economics Courses

Computer Engineering
- Most CS Courses
- Some EE Courses

Electrical & Electronic Engineering
- Digital & Analog Signal Processing in Telecommunications
- Power Engineering
- Power Systems Analysis
- Any ME Course
- Some CS Courses

Mechanical Engineering
- Fluid Mechanics & Applications
- Most EE Courses
- Some CS Courses
Practical Training

Third Year Service Learning Project & Seminar
- Team project
- Multidisciplinary
- Requires community involvement
- Students determine their learning goals

Internship

Fourth Year: Capstone or Corporate Project
- Individual or small group
- Substantial written and oral presentation
- Corporate Project: real-world engineering design & application
Conclusion

- Small engineering programme in small liberal arts-based University in West Africa
- General engineering based
- Emphasis on hands-on projects
- Focused study and discussions around leadership and ethics
- Developed in consultation with multiple stakeholders, and with local needs in a developing economy in mind
Questions?

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