ASHESI UNIVERSITY

ACADEMIC CATALOG

2021/2022

www.ashesi.edu.gh

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Ashesi University 2021-2022 Academic Catalog

ACADEMIC PROGRAMS, DEGREES AND DEGREE REQUIREMENTS

Mission & Vision Statements

The mission of Ashesi University is to educate a new generation of ethical, entrepreneurial leaders in Africa; to cultivate within our students the critical thinking skills, the concern for others and the courage it will take to transform a continent.

Our vision is an African renaissance driven by a new generation of ethical, entrepreneurial leaders. We aim to educate such leaders, and to drive a movement in African higher education to scale up the education of such leaders.

Academic Message

An Ashesi student's academic purpose is striving for excellence in citizenship, leadership, and scholarship to transform Africa.

Ashesi University Academic and Social Honor Codes

Academic Honor Code (2007): All members of each second-year class at Ashesi University vote on whether to pledge to abide by the Academic Honor Code or not. When a minimum of 66.7% of the class vote in favor of the pledge, the entire class is deemed committed to honoring the pledge, which simply states, "I will not cheat, and I will not allow my peers to cheat".

Social Honor Code (2018): Under the **code**, all members of the **Ashesi** community will now sign on to a new **pledge** of behavior, the **pledge** reads, "as a member of the **Ashesi** Community, I will act with honesty, integrity, and respect for others, and will hold my peers accountable to abide by these principles and by the **university's code** of conduct."

Undergraduate Degrees offered

Bachelor of Science (BSc.)

Department of Business Administration

BSc. in Business Administration

Department of Computer Science and Information Systems

BSc. in Computer Science
BSc. in Management Information Systems

Department of Engineering

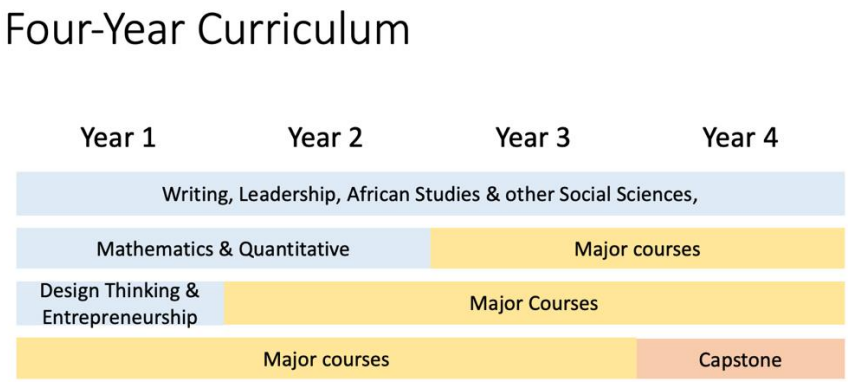
BSc. in Computer Engineering
BSc. in Electrical & Electronic Engineering
BSc. in Mechanical Engineering

Graduate Degrees Offered

MSc. in Mechatronic Engineering
MAS in Mechatronic Engineering
MPhil. in Mechatronic Engineering

Bachelor's Degree Requirements

Ashesi University offers an academic program consisting of a minimum of 134 semester hours (33.5 semester units) of credit for the bachelor's degree. The degree consists of a hybrid of foundational liberal arts core concentrated in year one, a professional core in a major, and elective courses.



Ashesi's academic calendar of 32 weeks a year is divided into two semesters, e.g., 16 weeks each, or 15 and 17 weeks, or 14 and 18 weeks. Post-COVID variations in the year one calendar have occurred to respond to the schedule of the national university entrance examinations. Students typically take four semester units per semester. A semester unit for a 16-week semester is 42 (3 hrs. X 14 weeks) classroom contact hours and a range of 14 discussion hours to 42 lab contact hours.

In European Credit Transfer and Accumulation System, ECTS, (using 1 ECTS = 25 hours) each of our degree programs is approximately 240 ECTS. (See page 75)

To earn a baccalaureate degree and be eligible for graduation, students are required to fulfil the following minimal requirements.

- Successful completion of at least **33.5** semester units, including all core and major requirements*
- A cumulative grade point average of 2.0 (C average) or higher
- Successful completion of the service-learning component**
- Successful completion of internship (required only for engineering students) ***
- Successful completion of writing across the curriculum course series (required pass for class of 2024 and subsequent classes) ****
- Fulfilment of all financial obligations to the University.

  * *Note that some Ashesi degree programs require more than **33.5** units, depending on a student's math track.*

  ***The **service-learning** component exists as another dimension of our commitment to nurture graduates who excel in citizenship. Service learning helps students develop a sense of citizenship by giving them an opportunity to become engaged with their surrounding community. Students must complete 40 hours of community service and fulfil this requirement in a variety of ways. The Outreach and Experiential Learning Programs office keeps a directory of non-profit organizations students can volunteer with.*

  *** *All Ashesi students are strongly encouraged to take up summer **internship** opportunities at the end of their second and third years. To ensure some level of familiarity with the practicing engineering profession, all Ashesi engineering students are required to either: do an internship at an engineering firm or an engineering-related internship at a non-engineering firm; shadow a practicing engineer; or engage in an engineering project for an external company.*

***** Beginning with the Class of 2024 all Ashesi students should obtain a pass in the Writing Across the Curriculum Lab series as a graduation requirement.*

Graduation Honors

Students who earn a cumulative GPA of 3.50 to 3.69 for all undergraduate work earn ***Cum Laude*** (honors). Those with a cumulative GPA of 3.70 to 3.84 for all undergraduate work earn ***Magna Cum Laude*** (high honors). Students with a cumulative GPA of 3.85 or above for all undergraduate work earn ***Summa Cum Laude*** (highest honors).

Summa Cum Laude: 3.85-4.00 (Highest Honors)

Magna Cum Laude: 3.70-3.84 (High Honors)

Cum Laude: 3.50-3.69 (Honors)

Bachelor's Degree: 2.00-3.49

Cum Laude and Class Distinctions

Ashesi University Honors	GPA	Public University (University of Cape Coast Honors)	GPA
Summa Cum Laude (Highest Honors)	3.85-4.00		
Magna Cum Laude (High Honors)	3.70-3.84	First Class	3.60 - 4.00
Cum Laude (Honors)	3.50-3.69	Second Class (Upper)	2.95 – 3.59
Bachelor's	2.00-3.49	Second Class (Lower)	2.45 – 2.94
		Third Class	2.00 – 2.44

Overview of Courses offered in Ashesi's Six Undergraduate Degree Programs

		Business Administration	Management Information System	Computer Science	Computer Engineering	Electrical and Electronic Engineering	Mechanical Engineering
LIBERAL ARTS & SCIENCES CORE	**Humanities & Social Sciences**	Written and Oral Comm. Text and Meaning Ashesi Seminar & Leadership 1* Leadership 2* Leadership 3* Leadership 4 Microeconomics Macroeconomics *6.5 Ashesi Units*	Written and Oral Comm. Text and Meaning Ashesi Seminar & Leadership 1* Leadership 2* Leadership 3* Leadership 4 Microeconomics Macroeconomics *6.5 Ashesi Units*	Written and Oral Comm. Text and Meaning Ashesi Seminar & Leadership 1* Leadership 2* Leadership 3* Leadership 4 Principles of Economics *5.5 Ashesi Units*	Written and Oral Comm. Text and Meaning Ashesi Seminar & Leadership 1* Leadership 2* Leadership 3* Leadership 4 (for Engineers) Principles of Economics *5.5 Ashesi Units*	Written and Oral Comm. Text and Meaning Ashesi Seminar & Leadership 1* Leadership 2* Leadership 3* Leadership 4 (for Engineers) Principles of Economics *5.5 Ashesi Units*	Written and Oral Comm. Text and Meaning Ashesi Seminar & Leadership 1* Leadership 2* Leadership 3* Leadership 4 (for Engineers) Principles of Economics *5.5 Ashesi Units*
	Business	Found. Of Design & Entre. I Found. Of Design & Entre. II *2 Ashesi Units*	Found. Of Design & Entre. I Found. Of Design & Entre. II *2 Ashesi Units*	Found. Of Design & Entre. I Found. Of Design & Entre. II Finance for Non-Finance Mgrs *3 Ashesi Units*	Found. Of Design & Entre. I Found. Of Design & Entre. II *2 Ashesi Units*	Found. Of Design & Entre. I Found. Of Design & Entre. II *2 Ashesi Units*	Found. Of Design & Entre. I Found. Of Design & Entre. II *2 Ashesi Units*
	Mathematics	Pre-Calculus 1 / Calculus 1 Pre-Calculus 2 / Calculus 2 Applied Calc (*Pre-Calc track only)* Statistics Quantitative Methods *4 Ashesi Units* *(5 if Pre-Calc track)*	Pre-Calculus 1 / Calculus 1 Pre-Calculus 2 / Calculus 2 Applied Calc *(Pre-Calc track only)* Statistics Quantitative Methods *4 Ashesi Units* *(5 if Pre-Calc track)*	Pre-Calculus 1 / Calculus 1 Pre-Calculus 2 / Calculus 2 Applied Calc *(Pre-Calc track only)* Statistics Quantitative Methods OR Linear Algebra *4 Ashesi Units* *(5 if Pre-Calc track)*	Calculus for Engineering / Calc 1 Calculus 2 (only if Calculus 1) Multivariable Calc. & Linear Alg Diff. Eqs. & Numerical Methods Statistics for Engineering *4 Ashesi Units* *(5 if Calc 1&2 track)*	Calculus for Engineering / Calc 1 Calculus 2 (only if Calculus 1) Multivariable Calc. & Linear Alg Diff. Eqs. & Numerical Methods Statistics for Engineering *4 Ashesi Units* *(5 if Calc 1&2 track)*	Calculus for Engineering / Calc 1 Calculus 2 (only if Calculus 1) Multivariable Calc. & Linear Alg Diff. Eqs. & Numerical Methods Statistics for Engineering *4 Ashesi Units* *(5 if Calc 1&2 track)*
	Computing	Intro to Computing & IS 1 Ashesi Unit	Intro to Computing & IS 1 Ashesi Unit	Intro to Computing & IS 1 Ashesi Unit	Computer Programming for Eng. 1 Ashesi Unit	Computer Programming for Eng. 1 Ashesi Unit	Computer Programming for Eng. 1 Ashesi Unit
	Science	*0 Ashesi Unit*	*0 Ashesi Unit*	*0 Ashesi Unit*	Physics I: Mechanics Physics II: Electromagnetism Material Science & Chemistry *3 Ashesi Units*	Physics I: Mechanics Physics II: Electromagnetism Material Science & Chemistry *3 Ashesi Units*	Physics I: Mechanics Physics II: Electromagnetism Material Science & Chemistry *3 Ashesi Units*
	Research / Project Prep.	Research Methods *1 Ashesi Unit*	Research Methods *1 Ashesi Unit*	Research Methods *1 Ashesi Unit*	3rd Yr. Grp. Project & Seminar* *0.5 Ashesi Unit*	*0.5 Ashesi Unit*	*0.5 Ashesi Unit*
		3 Non-Major Electives including at least 1 African studies *3 Ashesi Units*	3 Non-Major Electives including at least 1 African studies *3 Ashesi Units*	3 Non-Major Electives including at least 1 African studies *3 Ashesi Units*	2 Non-Major Electives including at least 1 African studies *2 Ashesi Units*	2 Non-Major Electives including at least 1 African studies *2 Ashesi Units*	3 Non-Major Electives including at least 1 African studies *2 Ashesi Units*
	Total Credits (Liberal Arts & Sciences)	**17.5 Ashesi Units** **(18.5 if Pre-Calc Track)**	**17.5 Ashesi Units** **(18.5 if Pre-Calc Track)**	**17.5 Ashesi Units** **(18.5 if Pre-Calc Track)**	**18 Ashesi Units** **(19 if Calc 1 & Calc 2 Track)**	**18 Ashesi Units** **19 if Calc 1 & Calc 2 Track)**	**18 Ashesi Units** **19 if Calc 1 & Calc 2 Track)**
MAJOR	**Required Major Classes**	Introduction to Finance Financial Accounting Marketing Managerial Accounting Corporate Finance Organizational Behavior International Trade & Policy Operations Management Business Law Competitive Strategy Investments *11 Ashesi Units*	Finance for Non-Finance Managers Managerial Accounting Competitive Strategy Computer Programming for CS Discrete Structures & Theory Database Management Web Technologies Systems Analysis & Design Information & Systems Security E-Commerce IT Infrastructure System Administration Lab* IS Project Management *12 Ashesi Units*	Computer Programming for CS Discrete Structures and Theory Data Structures & Algorithms Computer Org. & Arch. Human Computer Interaction Software Engineering Database Systems Intermediate Comp. Prog. Web Technologies Networks & Data Comm. Operating Systems Algorithm Design & Analysis *12 Ashesi Units*	Introduction to Engineering Instrumentation for Engineering* Applied Programming for Eng.* System Dynamics Control Systems Digital Systems Design Circuits & Electronics Project Mgmt. & Prof. Practice Embedded Systems Data Structures & Algorithms Operating Systems Networks & Distr. Computing Communication Systems Computer Org. & Arch. *13 Ashesi Units*	Introduction to Engineering Instrumentation for Engineering* Applied Programming for Eng.* System Dynamics Control Systems Digital Systems Design Circuits & Electronics Project Mgmt. & Prof. Practice Embedded Systems Intro to Electrical Machines & Power Electronics Advanced Electrical machines & Power Electronics Fundamentals of Thermal Fluid Science & Heat Transfer Communications Systems Power Engineering *13 Ashesi Units*	Introduction to Engineering Instrumentation for Engineering* Applied Programming for Eng.* System Dynamics Control Systems Digital Systems Design Circuits & Electronics Project Mgmt. & Prof. Practice Mechanical machine Design Intro to Electrical Machines & Power Electronics Fluid Dynamics & Applications Fundamentals of Thermal Fluid Science & Heat Transfer Mechanics of Materials / Structural Engineering Thermal Systems & Applications *13 Ashesi Units*
	Major Electives	3 BA Electives *3 Ashesi Units*	2 MIS Electives *2 Ashesi Units*	2 CS Electives *2 Ashesi Unit*	2 CE Electives *2 Ashesi Unit*	2 EE Electives *2 Ashesi Unit*	2 ME Electives *2 Ashesi Unit*
	Capstone	Capstone 1 (could be electives) Capstone 2 *2 Ashesi Units*	Capstone 1 (could be electives) Capstone 2 *2 Ashesi Units*	Capstone 1 (could be electives) Capstone 2 *2 Ashesi Units*	Capstone *2 Ashesi Units*	Capstone *2 Ashesi Units*	Capstone *2 Ashesi Units*
	Total Credits (Major)	**16 Credits**	**16 Credits**	**16 Credits**	**16 Credits**	**16 Credits**	**16 Credits**
	TOTAL CREDITS OVERALL	**33.5 Ashesi Units** **(34.5 if Pre-Calc track)**	**33.5 Ashesi Units** **(34.5 if Pre-Calc track)**	**33.5 Ashesi Units** **(34.5 if Pre-Calc track)**	**34 Ashesi Units** **(35if Calc 1 & Calc 2 Track)**	**34 Ashesi Units** **35 if Calc 1 & Calc 2 Track)**	**34 Ashesi Units** **35 if Calc 1 & Calc 2 Track)**

Business Administration, Management Information Systems, & Computer Science Programs: New 4 Year Curriculum (Transition Plan for Class of 2022 and Class of 2023)

Semester	Business Administration	Management Information System	Computer Science
Year 1			
Sem 1 Aug - Dec	Ashesi Success Pre-Calculus I or Calculus I Written and Oral Communication Foundations Design & Entrepreneurship 1 Introduction to Computing and Information Systems		
Sem 2 Jan - May	Leadership Seminar 1* Precalculus 2 or Calculus 2 Text and Meaning Foundations of Design and Entrepreneurship II		
	Organizational Behavior	Computer Programming for CS	Computer Programming for CS
Summer	Applied Calculus (Pre-Calculus Students only)		
Year 2			
Sem 1 Aug - Dec	Leadership Seminar 2* Statistics Microeconomics Financial Accounting **Non-Major Elective**[1]	Leadership Seminar 2* Statistics Microeconomics Discrete Structures & Theory **Non-Major Elective**[1] or Data Structures[2]	Leadership Seminar 2* Statistics Data Structures & Algorithms Discrete Structures & Theory **Non-Major Elective**[1] or Microeconomics[3]
Sem 2 Jan - May	Leadership Seminar 3* Quantitative Methods Macroeconomics Marketing[1] Introduction to Finance	Leadership Seminar 3* Quantitative Methods Macroeconomics[1] Database Systems Finance for non-Finance Managers	Leadership Seminar 3* Quantitative Methods or Multivariable Calculus & Linear Algebra Intermediate Comp Prog Database Systems Finance for non-Finance Managers[1]
Year 3			
Sem 1 Aug - Dec	International Trade & Policy Operations Management Investments Leadership Seminar 4 or **Elective†**	**Elective†** Web Technologies Systems Analysis & Design Leadership Seminar 4 or **Elective†**	Research Methods Web Technologies Computer Org & Architecture Leadership Seminar 4 or **Elective†**
Sem 2 Jan - May	Managerial Accounting Research Methods Elective† Leadership Seminar 4 or **Elective†**	Research Methods IT Infrastructure Systems Administration Lab* IS Project Management* Leadership Seminar 4 or **Elective†**	Software Engineering Algorithms Design & Analysis Principles of Economics Leadership Seminar 4 or **Elective†**
Year 4			
Sem 1 Aug - Dec	Corporate Finance Business Law **Elective†** Capstone 1	E-Commerce Information and Systems Security **Elective†** Capstone 1	Operating Systems Human Computer Interaction **Elective†** Capstone 1
Sem 2 Jan - May	Competitive Strategy **Elective†** **Elective†** Capstone 2	Competitive Strategy **Elective†** **Elective†** Capstone 2	Networks & Data Communications **Elective†** **Elective†** Capstone 2

* Half-credit course

[1] Students who wish to study French will take *Beginning French 1* as their non-major elective in Year 2 Sem 1. To continue with *Beginning French 2* in Year 2 Sem 2, they will postpone one required course (*Marketing* for BA majors, *Macroeconomics* for MIS majors, and *Finance for Non-Finance Managers* for CS majors) to the summer or to the elective slot in Year 3 Sem 2. They can continue with their study of French by taking *Professional French 1* and *Professional French 2* as course overloads in Year 3. Alternatively, they can free up space for French in Year 3 by taking summer courses after Year 2.

[2] Data Structures counts as a major elective for MIS majors and is encouraged for those who plan to do software development or those entering Year 2 who are still unsure about whether to major in MIS or CS

[3] Although *Principles of Economics* is prescribed for CS majors, *Microeconomics* can be substituted. As such, *Microeconomics* is recommended for students entering Year 2 who are still unsure about whether to major in CS or MIS

† Students have flexibility in scheduling electives (major and non-major) in Years 3 and 4 but must ensure that they take the total required number of major electives (3 for BA, 2 for MIS & CS) and non-major electives (3, including at least 1 Africana).

Computer Engineering, Electrical and Electronic Engineering, and Mechanical Engineering Programs: New 4 Year Curriculum (Transition Plan for Class of 2022 and Class of 2023)

Semester	Computer Engineering	Electrical and Electronic Engineering	Mechanical Engineering
Year 1			
Sem 1 Sep - Jan	Written and Oral Communication	Written and Oral Communication	Written and Oral Communication
	Calculus I	Calculus I	Calculus I
	Computer Programming for Engineering	Computer Programming for Engineering	Computer Programming for Engineering
	Giving Voice to Values	Giving Voice to Values	Giving Voice to Values
	Foundations Design & Entrepreneurship 1	Foundations Design & Entrepreneurship 1	Foundations Design & Entrepreneurship 1
Sem 2 Jan - May	Text and Meaning	Text and Meaning	Text and Meaning
	Calculus II	Calculus II	Calculus II
	Physics I: Mechanics	Physics I: Mechanics	Physics I: Mechanics
	Foundations Design & Entrepreneurship 2	Foundations Design & Entrepreneurship 2	Foundations Design & Entrepreneurship 2
	Leadership Seminar 1*	Leadership Seminar 1*	Leadership Seminar 1*
Summer	Introduction to Engineering	Introduction to Engineering	Introduction to Engineering
	Applied Programming for Engineers*	Applied Programming for Engineers*	Applied Programming for Engineers*
Year 2			
Sem 1 Aug - Dec	Physics II: Electromagnetism	Physics II: Electromagnetism	Physics II: Electromagnetism
	Statistics for Engineering	Statistics for Engineering	Statistics for Engineering
	Multivariable Calculus & Linear Algebra	Multivariable Calculus & Linear Algebra	Multivariable Calculus & Linear Algebra
	Data Structures & Algorithms	Thermodynamics	Thermodynamics
	Leadership Seminar 2*	Leadership Seminar 2*	Leadership Seminar 2*
Sem 2 Jan - May	Circuits and Electronics	Circuits and Electronics	Circuits and Electronics
	Materials Science & Chemistry	Materials Science & Chemistry	Materials Science & Chemistry
	Differential Equations & Numerical Methods	Differential Equations & Numerical Methods	Differential Equations & Numerical Methods
	Text and Meaning	Text and Meaning	Text and Meaning
	Leadership Seminar 3*	Leadership Seminar 3*	Leadership Seminar 3*
Year 3			
Sem 1 Aug - Dec	Computer Organization & Architecture	Intro Electrical Machines & Power Elect	Intro Electrical Machines & Power Elect
	System Dynamics	System Dynamics	System Dynamics
	Communication Systems	Communication Systems	Mechanics of Materials
	Leadership Seminar 4 for Engineers (Includes Year 3 Group Project)	Leadership Seminar 4 for Engineers (Includes Year 3 Group Project)	Leadership Seminar 4 for Engineers (Includes Year 3 Group Project)
	Instrumentation for Engineering*	Instrumentation for Engineering*	Instrumentation for Engineering*
Sem 2 Jan - May	Control Systems	Control Systems	Control Systems
	Networks & Data Communications	Adv Electrical Machines & Power Elect	Mechanical Machine Design
	Digital Systems Design	Digital Systems Design	Principles of Economics
	Principles of Economics	Principles of Economics	Fluid Mechanics
	Year 3 Group Project & Seminar*	Year 3 Group Project & Seminar*	Year 3 Group Project & Seminar*
Year 4			
Sem 1 Aug - Dec	Operating Systems	Power Engineering	African Studies Elective
	CE Elective	EE Elective	ME Elective
	Embedded Systems	Embedded Systems	Heat Transfer
	Elective	Elective	Elective
Sem 2 Jan - May	Project Mgmt and Professional Practice	Project Mgmt and Professional Practice	Project Mgmt and Professional Practice
	CE Elective	EE Elective	ME Elective
	African Studies Elective	African Studies Elective	Manufacturing Processes
	Senior Project & Seminar	Senior Project & Seminar	Senior Project & Seminar

Year IV Students desiring to do a Semester II elective should consider doing Africana in Semester 1 in place of "Elective" e.g., Year IV EE students wishing to do Networks should do Africana in Semester 1 and Networks in Semester II

Business Administration, Management Information Systems, & Computer Science Programs: 4 Year Curriculum (with Pre-matriculation Semester) – Class of 2024 and 2025

Semester	Business Administration	Management Information System	Computer Science
Year 1			
Pre-Matriculation Semester Aug 2020 - Jan 2021 Aug 2021 - Jan 2022	Entrepreneurship Universe Writing, Public Speaking and Multimedia Communication Creative Approaches to African Development Introduction to Computing and Information Systems Principles of Design Quantitative Estimation and Data Visualization **Optional Modules:** How to Communicate like a Leader Math Bridge for ENG English Bridge		
Sem 1 Jan 2021– May 2021 Jan 2022 –May 2022	Ashesi Success Pre-Calculus I or Calculus I Written and Oral Communication Foundations Design & Entrepreneurship 1 Introduction to Computing and Information Systems Leadership Seminar 1 (Class of 2024)		
Sem 2 Aug 2021- Dec2021 Aug 2022- Dec2022	Text and Meaning		
	Precalculus 2 or Calculus 2		
	Leadership Seminar 1* (Class of 2025)		
	Foundations of Design and Entrepreneurship II		
	Organizational Behavior	Computer Programming for CS	Computer Programming for CS
Year 2			
Sem 1 Jan 2022– May 2022 Jan 2023–May 2023	Leadership Seminar 2* (Class of 2025)	Leadership Seminar 2* (Class of 2025)	Leadership Seminar 2* (Class of 2025)
	Statistics	Statistics	Statistics
	Microeconomics	Microeconomics	Data Structures & Algorithms
	Financial Accounting	Discrete Structures & Theory	Discrete Structures & Theory
	Non-Major Elective[1]	Non-Major Elective[1] or Data Structures[2]	Non-Major Elective[1] or Microeconomics[3]
Sem 2 Aug 2022- Dec2022 Aug 2023- Dec2023	Leadership Seminar 3* (Class of 2025)	Leadership Seminar 3* (Class of 2025)	Leadership Seminar 3* (Class of 2025)
	Quantitative Methods	Quantitative Methods	Linear Algebra
	Macroeconomics	Macroeconomics[1]	Intermediate Comp Prog
	Marketing[1]	Database Systems	Database Systems
	Introduction to Finance	Finance for non-Finance Managers	Finance for non-Finance Managers[1]
Summer	Applied Calculus (Pre-Calculus Students only)		
Year 3			
Sem 1 Jan 2023– May 2023 Jan 2024–May 2024	International Trade & Policy	Managerial Accounting	Human Computer Interaction
	Operations Management	Web Technologies	Web Technologies
	Investments	Systems Analysis & Design	Computer Org & Architecture
	Leadership Seminar 4 or Elective†	Leadership Seminar 4 or Elective†	Leadership Seminar 4 or Elective†
Sem 2 Aug 2023- Dec2023 Aug 2024- Dec2024	Managerial Accounting	Research Methods	Software Engineering
	Research Methods	IT Infrastructure	Algorithms Design & Analysis
	Elective†	Systems Administration Lab*	Research Methods
		IS Project Management*	
	Leadership Seminar 4 or Elective†	Leadership Seminar 4 or Elective†	Leadership Seminar 4 or Elective†
Year 4			
Sem 1 Jan 2024– May 2024 Jan 2025 –May 2025	Corporate Finance	E-Commerce	Operating Systems
	Business Law	Information and Systems Security	Human Computer Interaction
	Elective†	Elective†	Elective†
	Capstone 1	Capstone 1 (Entrepreneurship 1 / Thesis 1/ Extra major elective)	Capstone 1 (Entrepreneurship 1 / Thesis 1/ Extra major elective)
Sem 2 Aug 2024 - Dec2024 Aug 2025 - Dec2025	Competitive Strategy	Competitive Strategy	Networks & Data Communications
	Elective†	Elective†	Elective†
	Elective†	Elective†	Elective†
	Capstone 2	Capstone 2 ((Entrepreneurship 2 / Thesis 2/ Extra major elective)	Capstone 2 ((Entrepreneurship 2 / Thesis 2/ Extra major elective)

* Half-credit course

[1] Students who have started studying French and wish to continue will take *Beginning French 2* in Year 2 Sem 2 as a non-major elective (BA majors would need to postpone *Marketing* to the summer or to the elective slot in Year 3 Sem 2). The study of French can continue in Year 3 by taking *Professional French 1* and *Professional French 2* as course overloads. Alternatively, students can free up space for French in Year 3 by taking summer courses after Year 2.

† Students have flexibility in scheduling electives (major and non-major) in Years 3 and 4, but must ensure that they ultimately have the needed number of major electives (3 for BA, 2 for MIS & CS) and non-major electives (3, including at least 1 Africana).

Computer Engineering, Electrical and Electronic Engineering, and Mechanical Engineering Programs: 4 Year Curriculum (with Pre-matriculation Semester) – Class of 2024 and 2025

Semester	Computer Engineering	Electrical and Electronic Engineering	Mechanical Engineering
Year 1			
Pre-Matriculation Semester Aug 2020 - Jan 2021 Aug 2021 - Jan 2022	Entrepreneurship Universe Writing, Public Speaking and Multimedia Communication Creative Approaches to African Development Introduction to Computing and Information Systems Principles of Design Quantitative Estimation and Data Visualization **Optional Modules:** How to Communicate like a Leader Math Bridge for ENG English Bridge		
Sem 1 Jan 2021– May 2021 Jan 2022 –May 2022	Written and Oral Communication	Written and Oral Communication	Written and Oral Communication
	Calculus I	Calculus I	Calculus I
	Introduction to Engineering	Introduction to Engineering	Introduction to Engineering
	Giving Voice to Values	Giving Voice to Values	Giving Voice to Values
	Foundations Design & Entrepreneurship 1	Foundations Design & Entrepreneurship 1	Foundations Design & Entrepreneurship 1
Sem 2 Aug 2021- Dec2021 Aug 2022- Dec2022	Computer Programming for Engineering	Computer Programming for Engineering	Computer Programming for Engineering
	Multivariable Calculus & Linear Algebra	Multivariable Calculus & Linear Algebra	Multivariable Calculus & Linear Algebra
	Engineering Mechanics	Engineering Mechanics	Engineering Mechanics
	Foundations Design & Entrepreneurship 2	Foundations Design & Entrepreneurship 2	Foundations Design & Entrepreneurship 2
	Leadership Seminar 1*	Leadership Seminar 1*	Leadership Seminar 1*
	Applied Programming for Engineers*	Applied Programming for Engineers*	Applied Programming for Engineers*
Year 2			
Sem 1 Jan 2022– May 2022 Jan 2023–May 2023	Physics: Electromagnetism	Physics: Electromagnetism	Physics: Electromagnetism
	Applied Programming for Engineering	Applied Programming for Engineering	Applied Programming for Engineering
	Discrete Mathematics	CAD/CAM	CAD/CAM
	Data Structures & Algorithms	Thermodynamics	Thermodynamics
	Leadership Seminar 2*	Leadership Seminar 2*	Leadership Seminar 2*
Sem 2 Aug 2022- Dec2022 Aug 2023- Dec2023	Circuits and Electronics	Circuits and Electronics	Circuits and Electronics
	Materials Science & Chemistry	Materials Science & Chemistry	Materials Science & Chemistry
	Differential Equations & Numerical Methods	Differential Equations & Numerical Methods	Differential Equations & Numerical Methods
	Statistics for Engineering	Statistics for Engineering	Statistics for Engineering
	Text and Meaning	Text and Meaning	Text and Meaning
	Leadership Seminar 3*	Leadership Seminar 3*	Leadership Seminar 3*
Year 3			
Sem 1 Jan 2023– May 2023 Jan 2024–May 2024	Computer Organization & Architecture	Electrical Machines	Electrical Machines
	System Dynamics	System Dynamics	System Dynamics
	Signals & Systems	Signals & Systems	Mechanics of Materials
	Leadership Seminar 4 for Engineers (Includes Year 3 Group Project)	Leadership Seminar 4 for Engineers (Includes Year 3 Group Project)	Leadership Seminar 4 for Engineers (Includes Year 3 Group Project)
	Instrumentation for Engineering*	Instrumentation for Engineering*	Instrumentation for Engineering*
Sem 2 Aug 2023- Dec2023 Aug 2024- Dec2024	Control Systems	Control Systems	Control Systems
	Networks & Data Communications	Adv Electrical Machines & Power Elect	Mechanical Machine Design
	Digital Systems Design	Digital Systems Design	Fluid Mechanics
	Intermediate Computer Programming	Communication Systems	Manufacturing Processes
	Year 3 Group Project & Seminar*	Year 3 Group Project & Seminar*	Year 3 Group Project & Seminar*
Year 4			
Sem 1 Jan 2024– May 2024 Jan 2025–May 2025	Operating Systems	Power Engineering	Mechanics of Machines
	CE Elective	EE Elective	ME Elective
	Principles of Economics	Principles of Economics	Principles of Economics
	Embedded Systems	Embedded Systems	Heat Transfer
	Elective	Elective	Elective
Sem 2 Aug 2024- Dec2024 Aug 2025- Dec2025	Project Management and Professional Practice	Project Management and Professional Practice	Project Management and Professional Practice
	CE Elective	EE Elective	ME Elective
	African Studies Elective	African Studies Elective	Manufacturing Processes
	Senior Project & Seminar	Senior Project & Seminar	Senior Project & Seminar

EE Year 4: students wishing to do Networks should do Africana in Sem 1 and Networks in Sem II
CE: Year 4: if desiring to do a Sem II elective, consider doing Africana in Sem 1

PLANS OF STUDY PER YEAR, SEMESTER, and PROGRAM

Plan of Study: Business Administration

ASHESI UNIVERSITY Department of Business Administration			
BSc. Business Administration			
Ashesi Courses:			
Freshman Undergraduate	**Sophomore Undergraduate**	**Junior Undergraduate**	**Senior Undergraduate**
YEAR 1 **SEMESTER 1 & 2**	**YEAR 2** **SEMESTER 3 & 4**	**YEAR 3** **SEMESTER 5 & 6**	**YEAR 4** **SEMESTER 7 & 8**
PRE-MATRICULATION Entrepreneurship Universe Writing, Public Speaking and Multimedia Communication Creative Approaches to African Development Introduction to Computing and Information Systems Principles of Design Quantitative Estimation and Data Visualization **Optional Modules:** How to Communicate like a Leader Math Bridge English Bridge			
SEMESTER 1 • Ashesi Success • Pre-calculus 1 or Calculus 1 (4 credits) • Written & Oral Communication (4 credits) • Foundations of Design & Entrepreneurship 1 (4 credits) • Introduction to Computing and Information Systems (4 credits)	**SEMESTER 3** • Leadership Seminar 2 (2 credits) • Statistics (4 credits) • Microeconomics (4 credits) • Financial Accounting (4 credits) • Non- Major Elective (4 credits)	**SEMESTER 5** • Operations Management (4 credits) • Investments (4 credits) • International Trade & Policy (4 credits) • Leadership Seminar IV or Elective (4 credits)	**SEMESTER 7** • Corporate Finance (4 credits) • Business Law (4 credits) • Elective (4 credits) • Capstone 1 (4 credits or 4.5)
SEMESTER 2 • Leadership Seminar 1 (2 credits) • Precalculus 2 or Calculus 2 (4 credits) • Text and Meaning (4 credits) • Foundations of Design and Entrepreneurship II (4 credits) • Organizational Behavior (4 credits)	**SEMESTER 4** • Leadership Seminar 3 (2 credits) • Quantitative Methods (4 credits) • Macroeconomics (4 credits) • Marketing (4 credits) • Introduction to Finance (4 credits) **SUMMER** Applied Calculus (Pre-Calculus Students only)	**SEMESTER 6** • Research Methods (4 credits) • Managerial Accounting (4 credits) • Business Elective (4 credits) • Leadership Seminar IV or Elective (4 credits)	**SEMESTER 8** • Competitive Strategy (4 credits) • Elective (4 credits) • Elective (4 credits) • Capstone 2 (4 credits or 4.5)
Total Credits: 34-38	**Total Credits: 36**	**Total Credits: 28**	**Total Credits: 32**

Total Credits for BA Program=134-139

Plan of Study: Computer Science

ASHESI UNIVERSITY
Department of Computer Science and Information Systems

BSc. Computer Science

Ashesi Courses:

Freshman Undergraduate	Sophomore Undergraduate	Junior Undergraduate	Senior Undergraduate
YEAR 1 **SEMESTER 1 & 2**	**YEAR 2** **SEMESTER 3 & 4**	**YEAR 3** **SEMESTER 5 & 6**	**YEAR 4** **SEMESTER 7 & 8**
PRE-MATRICULATION Entrepreneurship Universe Writing, Public Speaking and Multimedia Communication Creative Approaches to African Development Introduction to Computing and Information Systems Principles of Design Quantitative Estimation and Data Visualization **Optional Modules:** How to Communicate like a Leader Math Bridge English Bridge			
SEMESTER 1 • Ashesi Success • Pre-calculus 1 or Calculus 1 • Written & Oral Communication • Foundations of Design & Entrepreneurship • Intro. To Computing & Information Systems	**SEMESTER 3** • Leadership Seminar 2 • Statistics • Microeconomics • Discrete Structures & Theory • Data Structures & Algorithms Non-Major Elective or Microeconomics	**SEMESTER 5** • Human Computer Interaction • Web Technologies • Computer Organization & Architecture • Systems Analysis & Design	**SEMESTER 7** • Operating Systems • Human Computer Interaction • Elective • CSIS Capstone Seminar Thesis 1
SEMESTER 2 • Leadership 1 • Pre-calculus 2 or Calculus 2 • Text & Meaning • Foundations of Design & Entrepreneurship 2 • Computer Programing for CS	**SEMESTER 4** • Leadership Seminar 3 • Multivariable Calc, & Linear Algebra • Intermediate Computer Programing (4.5 credits) • Finance for non-finance managers (4 credits) • Database Systems (4.5 credits) **SUMMER** Applied Calculus (Pre-Calculus Students only)	**SEMESTER 6** • Software Engineering (4.5 credits) • Algorithms Design & Analysis (4 .5 credits) • Research Methods (4 credits) • Leadership Seminar 4 or Elective (4 credits)	**SEMESTER 8** • Networks & Data Communications (4 .5credits) • Elective (4 credits) • Elective (4 credits) • CSIS Capstone Seminar Applied project (4 credits)
Total Credits: 34.5	**Total Credits: 37.5**	**Total Credits: 35**	**Total Credits: 33**

Total Credits for CS Program=134

Plan of Study: Management Information Systems

ASHESI UNIVERSITY
Department of Computer Science and Information Systems

BSc. Management Information Systems

Ashesi Courses:

Freshman Undergraduate	Sophomore Undergraduate	Junior Undergraduate	Senior Undergraduate
YEAR 1 **SEMESTER 1 & 2**	**YEAR 2** **SEMESTER 3 & 4**	**YEAR 3** **SEMESTER 5 & 6**	**YEAR 4** **SEMESTER 7 & 8**
PRE-MATRICULATION Entrepreneurship Universe Writing, Public Speaking and Multimedia Communication Creative Approaches to African Development Introduction to Computing and Information Systems Principles of Design Quantitative Estimation and Data Visualization **Optional Modules:** How to Communicate like a Leader Math Bridge English Bridge			
SEMESTER 1 • Ashesi Success (0 credit) • Pre-calculus 1 or Calculus 1 (4 credits) • Written & Oral Communication (4 credits) • Foundations of Design & Entrepreneurship (4 credits) • Intro. To Computing & Information Systems (4 credits)	**SEMESTER 3** • Leadership Seminar 2 (2 credits) • Statistics (4 credits) • Micro-Economics (4 credits) • Discrete Structures & Theory (4 credits) • Non-Major Elective or Data Structures (4 credits)	**SEMESTER 5** • Leadership Seminar 4 or Major Elective (4 credits) • Major Elective or Africana (4 credits) • Web Technologies (4.5 credits) • Systems Analysis & Design (4 .5credits)	**SEMESTER 7** • E-Commerce (4 credits) • Information and Systems Security (4 credits) • Elective (4 credits) • Capstone 1 (Entrepreneurship 1/Thesis 1/ Extra major elective) (4 credits)
SEMESTER 2 • Leadership Seminar 1 (2 credits) • Pre-calculus 2 or Calculus 2 (4 credits) • Text & Meaning (4 credits) • Foundations of Design & Entrepreneurship 2 (4 credits) • Computer Programming for CS (4.5 credits)	**SEMESTER 4** • Leadership Seminar 3 (2 credits) • Quantitative Methods (4 credits) • Macroeconomics (4 credits) • Database Systems (4.5 credits) • Finance for non-finance managers (4 credits) • **SUMMER** Applied Calculus (Pre-Calculus Students only)	**SEMESTER 6** • Leadership Seminar 4 or Major Elective (4 credits) • Research Methods (4 credits) • IT Infrastructure (4 .5credits) • Systems Administration Laboratory (2 credits) • IS Project Management (2 credits)	**SEMESTER 8** **Take the following 12 credits of graduate courses** • Competitive Strategy (4 credits) • Capstone 2 (Entrepreneurship 2/ Thesis 2/ Applied Project) (4 credits) • Elective (4 credits) • Elective (4 credits)
Total Credits: 34.5	**Total Credits: 36.5**	**Total Credits: 33.5**	**Total Credits: 32**

Total Credits for MIS Program=136.5

Plan of Study: Computer Engineering

ASHESI UNIVERSITY (ASHESI)
Department of Engineering

BSc. Computer Engineering

Ashesi Courses:

Freshman Undergraduate	Sophomore Undergraduate	Junior Undergraduate	Senior Undergraduate
YEAR 1 **SEMESTER 1 & 2**	**YEAR 2** **SEMESTER 3 & 4**	**YEAR 3** **SEMESTER 5 & 6**	**YEAR 4** **SEMESTER 7 & 8**
PRE-MATRICULATION Entrepreneurship Universe Writing, Public Speaking and Multimedia Communication Creative Approaches to African Development Introduction to Computing and Information Systems Principles of Design Quantitative Estimation and Data Visualization **Optional Modules:** How to Communicate like a Leader Math Bridge for ENG English Bridge			
SEMESTER 1 • Ashesi Success (0 credit) • Calculus for Engineering (4 credits) • Written & Oral Communication (4 credits) • Foundations of Design & Entrepreneurship 1 (4 credits) • Introduction to Engineering (6 credits)	**SEMESTER 3** • Physics: Electromagnetism (6 credits) • Applied Programming for Engineers (2 credits) • Data Structures & Algorithm (4 credits) • Leadership Seminar 2 (2 credits)	**SEMESTER 5** • Computer Organization & Architecture (4.5 credits) • System Dynamics (6 credits) • Signals & Systems (6 credits) • Leadership Seminar 4 for Engineers (includes Year 3 Group Project) (4 credits) • Instrumentation for Engineering (2 credits)	**SEMESTER 7** • Operating System (6 credits) • CE Elective (4 credits) • Principles of Economics (4 credits • Embedded Systems (6 credits) • Electives (4 credits)
SEMESTER 2 • Computer Programming for Engineering (4 credits) • Multivariable Calculus & Linear Algebra (4 credits) • Physics: Mechanics (6 credits) • Foundations of Design & Entrepreneurship 2 (4 credits) • Leadership Seminar 1 (2 credits)	**SEMESTER 4** • Leadership Seminar 3 (2 credits) • Circuits and Electronics (6 credits) • Materials Science & Chemistry (6 credits) • Differential Equations & Numerical Methods (4 credits) • Text and Meaning (4 credits) • Statistics for Engineering (4 credits)	**SEMESTER 6** • Control Systems (6 credits) • Networks & Data Communications (6 credits) • Intermediate Computer Programming (4.5 credits) • Digital Systems Design (4.5 credits) • CE Electives (4 credits) • Year 3 Group Project & Seminar (2 credits)	**SEMESTER 8** • Project Management and Professional Practice (4 credits) • CE Elective (4 credits) • African Studies Elective (4 credits) • Senior Project & Seminar (4 credits)
Total Credits: 37	**Total Credits: 42**	**Total Credits: 41.5**	**Total Credits: 36**

Total Credits for Computer Engineering Program=136

Plan of Study: Electrical & Electronic Engineering

ASHESI UNIVERSITY (ASHESI)
Department of Engineering

BSc. Electrical Engineering

Ashesi Courses:

Freshman Undergraduate	Sophomore Undergraduate	Junior Undergraduate	Senior Undergraduate
YEAR 1 **SEMESTER 1 & 2**	**YEAR 2** **SEMESTER 3 & 4**	**YEAR 3** **SEMESTER 5 & 6**	**YEAR 4** **SEMESTER 7 & 8**
PRE-MATRICULATION Entrepreneurship Universe Writing, Public Speaking and Multimedia Communication Creative Approaches to African Development Introduction to Computing and Information Systems Principles of Design Quantitative Estimation and Data Visualization **Optional Modules:** How to Communicate like a Leader Math Bridge for ENG English Bridge			
SEMESTER 1 • Calculus for Engineering (4 credits) • Written & Oral Communication (4 credits) • Foundations of Design & Entrepreneurship 1 (4 credits) • Introduction to Engineering (4 credits)	**SEMESTER 3** • Physics Electromagnetism (6 credits) • Applied Programming for Engineers (2 credits) • CAD/CAM (4 credits) • Thermodynamics (6 credits) • Leadership Seminar 2 (2 credits)	**SEMESTER 5** • Electrical Machines (6 credits) • System Dynamics (6 credits) • Signals & Systems (6 credits) • Leadership 4 for Engineers (includes Year 3 Group Project) (4 credits) • Instrumentation for Engineers (2 credits	**SEMESTER 7** • Power Engineering (6 credits) • EE Elective (4 credits) • Principles of Economics (4 credits) • Embedded Systems (6 credits) • Elective (4 credits)
SEMESTER 2 • Computer Programming for Engineering (4 credits) • Multivariable Calculus & Linear Algebra (4 credits) • Engineering Mechanics (6 credits) • Foundations of Design & Entrepreneurship 2 (4 credits) • Leadership Seminar 1 (2 credits)	**SEMESTER 4** • Leadership Seminar 3 (2 credits) • Circuits & Electronics (6 credits) • Statistics for Engineers (4 credits) • Text and Meaning (4 credits) • Material Science & Chemistry (6 credits) • Differential Equations & Numerical Methods (4 credits)	**SEMESTER 6** • Control Systems (6 credits) • Adv Electrical Machines & Power Elect II OR Embedded Systems (6 credits) • Digital Systems Design (4.5 credits) • Communication Systems (4.5 credits) • Year 3 Group Project & Seminar (2 credits) • EE Elective (4 credits)	**SEMESTER 8** • Project Management and Professional Practice (4 credits) • EE Elective (4 credits) • African Studies Elective (4 credits) • Senior Project 2 & Seminar (4 credits)
Total Credits: 36	**Total Credits: 38**	**Total Credits: 46**	**Total Credits: 36**

Total Credits for Electrical Engineering Program=136

Plan of Study: Mechanical Engineering

ASHESI UNIVERSITY (ASHESI)
Department of Engineering

BSc. Mechanical Engineering

Ashesi Courses:

Freshman Undergraduate	Sophomore Undergraduate	Junior Undergraduate	Senior Undergraduate
YEAR 1 **SEMESTER 1 & 2**	**YEAR 2** **SEMESTER 3 & 4**	**YEAR 3** **SEMESTER 5 & 6**	**YEAR 4** **SEMESTER 7 & 8**
PRE-MATRICULATION Entrepreneurship Universe Writing, Public Speaking and Multimedia Communication Creative Approaches to African Development Introduction to Computing and Information Systems Principles of Design Quantitative Estimation and Data Visualization **Optional Modules:** How to communicate like a leader Math Bridge for ENG English Bridge			
SEMESTER 1 • Calculus for Engineering 1 (4 credits) • Written & Oral Communication (4 credits) • Foundations of Design & Entrepreneurship (4 credits) • Introduction to Engineering (6 credits)	**SEMESTER 3** • Physics: Electromagnetism (6 credits) • Applied Programming for Engineers (2 credits) • CAD/CAM (4 credits) • Thermodynamics (6 credits) • Leadership Seminar 2 (2 credits)	**SEMESTER 5** • Electrical Machines (6 credits) • System Dynamics (6 credits) • Mechanics of Materials (6 credits) • Leadership 4 for Engineers (Includes Year 3 Group Projects) (4 credits) • Instrumentation for Engineering (2 credits)	**SEMESTER 7** • Mechanics of Machines (6 credits) • ME Elective (4 credits) • Principles of Economics (4 credits) • Heat Transfer (6 credits) • Elective (4 units)
SEMESTER 2 • Computer Programming for Engineering (4.5 credits) • Multivariable Calculus & Linear Algebra (4 credits) • Engineering Mechanics (6 Credits) • Foundations of Design & Entrepreneurship 2 (4 credits) • Leadership Seminar 1 (2 credits)	**SEMESTER 4** • Leadership Seminar 3 (2 credits) • Circuits & Electronics (6 credits) • Material Science & Chemistry (6 credits) • Differential Equations & Numerical Methods (4 credits) • Statistics for Engineering (4 credits) • Text and Meaning (4 credits)	**SEMESTER 6** • Control Systems (6 credits) • Mechanical Machine Design (6 credits) • Fluid Mechanics (6 credits) • Manufacturing Processes (6 credits) • Year 3 Group Project & Seminar (2 credits) • ME Elective (4 credits)	**SEMESTER 8** • Project Management & Professional Practice (4 credits) • ME Elective (4 credits) • Manufacturing Processes (6 credits) • Senior Project 2 & Seminar (4 credits)
Total Credits: 37.5	**Total Credits: 46**	**Total Credits: 54**	**Total Credits: 42**

Total Credits for ME Program= 179.5

DESCRIPTIONS OF COURSES and PREREQUISITES

Business Administration

BUSA 001 Entrepreneurship Universe
Required for Freshman students
Prerequisite: none
Offered: Fall
Course Type: Lecture, Seminar, Experiential
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1 Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

Entrepreneurship Universe is a four-week introductory overview of the entrepreneurial discipline. The module will take students on an exciting journey of understanding and connecting dots in selected domains of entrepreneurship as deemed relevant. Specific aspects to be covered will include definition and evolution of entrepreneurship, the role of entrepreneurship in economic development, forms of entrepreneurial endeavors, myths of entrepreneurship, key characteristics of entrepreneurs, what the entrepreneurship process entails within and outside our context, among others.

BUSA 100 Principles of Economics
Required for all CS & ENG majors
Prerequisite: Pre-Calculus 2 or Calculus 1
Offered: Fall
Course Type: Lecture
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1 Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

The aim of the course is to introduce students to the fundamental principles, ideas, concepts, and tools of microeconomic and macroeconomic theories. Also, the course focuses on equipping students with economic knowledge relevant in helping them make informed economic decisions and inferences.

This course will introduce students to the principles of microeconomics and macroeconomics. It is aimed at equipping students with economic knowledge relevant in helping them contribute to economic discussions and make better business decisions. The course will also enable students to understand the connection between microeconomics and macroeconomics, and their practical relationships. We will develop economic tools that are necessary for strategic decision making in the business environment. At the end of the course students should have achieved some understanding of and gained competence in using economic ideas, tools, and procedures.

BUSA 132 Organizational Behavior
Required for all BA majors
Prerequisite: None
Offered: Typically taught in Fall
Course Type: Lecture
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1 Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

How can managers motivate employees to go above the call of duty to get the job done? How can managers be sure their decisions are not biased? What influence tactics can managers use when they do not have formal authority to tell someone what to do? This course will help students understand life in complex organizations by covering topics that span microanalysis dealing with individuals and macro

analysis dealing with the organization. The course is managerial in orientation and focuses on the processes necessary to organize, motivate, direct and control people engaged in collective activities. The emphasis is on the development of concepts and strategies that will help students become managers that are more effective. The course uses readings, cases, exercises and videos to illustrate the conceptual and applied aspects of individual, group and organizational behavior.

BUSA 161/A Foundation of Design & Entrepreneurship I
Required for all Ashesi students
Prerequisite: none
Offered: Fall
Course Type: Lecture, Experiential
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1 Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

This is the first part of a yearlong course on design and entrepreneurship. The goal of the course is to immerse all first-year students of the University, irrespective of major, into the world of design thinking, entrepreneurship and business management. For this semester's work, the course will cover two main aspects: design thinking for problem solving and entrepreneurial opportunity analysis. The two areas will involve students undertaking exercises to help hone their skills in design thinking, conduct business opportunity identification and analysis culminating in business concepts. Students will then develop and validate their business concepts and present them for evaluation. The first half of this semester will look at creativity, design thinking and innovation with the aim of positioning students to develop an innovative posture. Class sessions and activities will see students uncovering how the brain creates and prevents creativity, how to reframe problems, conduct research, conduct sensemaking to uncover insights from research, develop a point of view, ideate, prototype and develop solutions to the problems identified. The key focus areas are teaching them how to deal with ambiguity and be innovative and creative, in the midst of limitations and constraints. Students will also learn how to prototype and test their ideas with users. The second half of the semester will be structured to help students evaluate their design proposals and decide on how to take them further. Building on the background from the design module, students will study business opportunity analysis and business model development as entrepreneurs and intrapreneurs. They will run through the theories of business venture modelling to help them model their business concepts. This will serve as a basis for using tools like the business model canvas, which will require that students identify potential customer segments, develop and test value propositions that address their pain points, problems or needs they discovered in the first part of the course. At the end of the semester, students will reflect on the course, as well as present their business concepts for evaluation and selection for the business simulation project in the second semester.

BUSA 162 Foundation of Design & Entrepreneurship II
Required for all Ashesi students
Prerequisite: FDE 1
Offered: Spring
Course Type: Lecture, Experiential
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1 Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

This course is a continuation of Foundations of Design and Entrepreneurship (FDE) I and aims to build on the work done through business simulations on the solution concepts developed. The venture teams will start the semester with continued prototyping, developing, and testing their Minimum Viable Products (MVP), launching their venture concept, and running post-launch promotions, all the while learning about

the key entrepreneurship concepts that pertain to the various activities performed in this course. However, the venture teams will not be registered legal entities during the period of the class (perhaps afterwards). Hence, we refer to the nature of the business the venture team conducts during the semester as a business simulation. To elaborate on the process, by conducting Customer Discovery, Customer Validation and exploring Customer Creation and Company Building hypothetically, FDE II teams can test and update their business concepts into validated business ideas that can potentially be explored post FDE. The testing process is iterative as teams will need to incorporate new information or pivot based on outcomes from testing in the rather continuous customer development process. Such informed customer discovery, validation and creation activities will reveal the viability of the business concept and therefore help the team determine if a business concept has prospects for company building or not by the end of the semester. The simulation process therefore provides a rigorous experiential learning corridor through which FDE teams encounter, experience, and process relevant business knowledge for business venturing in entrepreneurship (as well as in intrapreneurship at the corporate level). Towards the end of the semester, students will be guided in determining how they will transition out of the FDE program after two semesters. If they determine that their business venture should go into the Company Building phase, they will have the opportunity to enroll in the student-led Ashesi Start-up Launchpad. If they decide that they are not interested in pursuing the venture, the team will be assisted in exiting the simulation, resolving inventory, and closing the books.

BUSA 210 Financial Accounting
Required for all BA majors
Prerequisite: none
Offered: Fall or Summer
Course Type: Lecture
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1 Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

This is an introductory accounting course that exposes students to fundamental accounting principles, the regulatory framework of accounting practice, elements of financial statements, the mechanics of data entry, preparation of financial statements, financial statement analysis, control accounts and reconciliations, and ethics in the accounting profession. The course is designed to provide students with the requisite skills for analyzing transactions, opening, and maintaining proper books of accounts, doing basic reconciliations, preparing financial statements for sole proprietorships, applying fundamental accounting principles and ethical codes in solving accounting and business problems, and evaluating the financial performance of a business entity using financial statement analysis.

BUSA 220 Introduction to Finance
Required for all BA majors
Prerequisite: Financial Accounting
Offered: Spring or Summer
Course Type: Lecture
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1 Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

This is an introductory course aimed at equipping students with the basic skills of corporate finance. In this course, students will be introduced to some fundamental principles of corporate finance such as time value of money and risk. Specific areas of concentration include the time value of money, investment valuation and decision making under conditions of certainty and uncertainty, working capital

management, capital budgeting, cost of capital, capital structure and dividend policy, and intermediate and long-term financing.

BUSA 224 Finance for non-Finance
Required for all MIS & CS majors
Prerequisite: Pre-calculus 1 & 2 or Calculus 1; Prior or concurrent enrolment in Microeconomics
Offered: Spring & Summer
Course Type: Lecture
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1 Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

This course is designed to equip students with the necessary tools, skills and competencies required of contemporary managers of top-notch organizations to properly handle financial management and planning issues. It is a platitude that almost every activity in an organization has some monetary implications, hence may translate into numbers. Managers must therefore be trained to know how their actions and inactions affects the numbers, which in turn affect the entity's profitability; a critical ingredient necessary for the long-term survival of the business. The course is organized under four main thematic areas – understanding the business, tax, and finance environments; understanding financial statements; effective cost management and planning; and effective financial decision-making. Materials for the course will be delivered through lectures and class presentations of relevant cases, which draw on specific concepts discussed to enhance students' understanding.

BUSA 304 Operations Management
Required for all BA majors
Prerequisite: Quantitative Methods or Statistics for Engineering & Economics
Offered: Fall
Course Type: Lecture
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1 Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

The study of Operations Management this spring semester will take you on a journey of the principles, strategies and tools required to manage any part of an organization that is involved in the provision of goods and or services. The activities involved in the transformation of a need of a product and or service into the actual product or service is an intriguing process which covers a huge part of a typical organization. The transformation process offers a lot of opportunities for achieving competitive advantage and the manager of any part of the process or at any strategic level in an Organization needs to understand how the various processes fit together, what the implications are for the weakest part of the process, identify opportunities for continuous improvement and also see from a bird's eye view, the approach leadership must take to ensure profitability, growth, continuous improvement, development of employees and sustainability. While looking out for all the above factors, there is also the issue of ensuring that the organization, institution, or company is here for the long haul through a consistent review of sustainability requirements.

BUSA 311 Managerial Accounting
Required for all BA & MIS majors
Prerequisite: Financial Accounting or Finance for non-Finance Managers
Offered: Spring or Summer
Course Type: Lecture

Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1 Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

Students will learn how to use financial information to identify and analyze alternative projects to be undertaken by the entity to optimize profitability. They will develop the critical analytical skills necessary for identifying and using relevant costs and related issues, which form the bedrock for cost-effective managerial decision making.

BUSA 321 Investments
Required for all BA majors
Prerequisite: Introduction to Finance or Finance for non-Finance Managers
Offered: Fall or Summer
Course Type: Lecture
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1 Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

This course surveys the investment media, concepts, and techniques to provide an understanding of the investment process in the economic and financial environment. The course covers the elements of investments, portfolio theory and management, security analysis, valuation of stocks and bonds, and risk-return trade-off. The course entails only the necessary mathematical and technical details which will provide the intuition that may illuminate the gliding path for students as they confront new ideas and challenges in their later lives as investment practitioners. On the conviction that theories such as the capital asset pricing model and the efficient market hypothesis are intellectually satisfying subjects of scientific research as they are important building blocks for the development of solid grounding in investments, aspects of these theories will be used generously to determine the value of real and financial assets. As the instructor tries to bridge the gap between theory and practice, several real-world examples are presented. The course will consist of lectures and discussions of contemporary investment and finance challenges and developments in Ghana and across the globe. In particular, students will be exposed to trends in socially responsible investing around the globe and what lessons Ghanaian Fund Managers can take. A good dose of data will be used in the 'analysis' part of the course. Students will be required to use Microsoft Excel analytic tools to solve a large part of the problem sets. This is also intended to provide students with a taste of tools they will need to understand and use in their career as investment analysts.

BUSA 341 Marketing
Required for all BA majors.
Prerequisite: Micro-economics
Offered: Spring
Course Type: Lecture
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1. Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

Marketing is a key driver of success in today's dynamic organizations. This course will give you an insight into marketing concepts and tools and how these are applied to deliver results. The essential or big question this course seeks to answer is "How do organizations, especially private, for-profit enterprises, create value for customers, clients or stakeholders while achieving the objectives of the organizations in a dynamic, digitized business environment?"

Students will be exposed to and given the opportunity to apply foundational knowledge of marketing concepts, principles and skills that thriving firms or organizations use to undertake the following critical marketing tasks:

Understand consumer needs and wants as well as identify opportunities and threats in the marketplace.
Decide which target markets to serve best.
Develop a compelling value proposition by which the firm can grow and win in the marketplace.
Craft an integrated marketing plan to deliver superior value, appeal to customers, build lasting relationships with target customers and deliver sustainable profitable returns to the organization.

Students are expected at the end of the course to demonstrate the strategic marketing management skills of understanding customer preferences, designing relevant products and service value propositions to meet the needs of selected customers, and determining appropriate means of communicating, delivering, and capturing value for customers and the firm respectively.

BUSA 350 International Trade & Policy
Required for all BA majors
Prerequisite: Pre-calculus 1; Micro-economics; Macro-economics; Statistics
Offered: Spring
Course Type: Lecture
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1 Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

The course is designed to introduce students to the main concepts and methods of international trade using applications drawn from the real world. Throughout the course, we would convey the major ideas that have emerged from recent research while emphasizing the continued importance of the old theories. Throughout this course, the objective is to guide students to understand how the evolution of international economic theory has helped shape our understanding of a rapidly changing global economy. Also, how we can use the knowledge about international trade to contribute to the on-going debate about trade protection, free trade, regionalism and trade preferences among other issues.

BUSA 400A_B Thesis 1 & 2
Capstone option for BA, MIS, CS
Prerequisite: 8 Credits in Major Area of Study
Offered: Fall & Spring
Course Type: Seminar
Ashesi Units: 1; Credit Hours: 3; Hours per week classroom: 1.5; Hours per week discussion: N/A Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 10 per week)

Send an e-mail to sagyepong@ashesi.edu.gh if you need further information on the BA Thesis capstone process.

BUSA 401_A Entrepreneurship 1
Capstone option for BA, MIS, CS
Prerequisite: 8 Credits in Major Area of Study
Offered: Fall
Course Type: Seminar, Experiential

Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1. Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

Entrepreneurship has been held by many as the key to development in the underdeveloped world. This is because it holds the potential of aiding problem solving through the development of innovative products and services. These will also help in reducing unemployment by serving as income generation avenues for the youth. If Africa, and indeed other developing economies, can achieve the Sustainable Development Goals (SDG), there will be the need to develop profit generating enterprises as well as social enterprises to serve as the backbone and propellant.

This capstone session, in a bid to further position Ashesi graduates to understand the nuances of start-ups and the entrepreneurial mindset to develop into entrepreneurs and intrapreneurs, integrates the skills and knowledge obtained from courses offered in the past three years of the student's education on campus. It will teach students what a start-up is and make the clear distinction between a start-up and a small business. It will take students through opportunity analysis and the development of sustainable business models using Eric Ries' *Lean StartUp*, Steve Blank's *Customer Development Process* and Alexander Osterwalder's *Business Model Canvas*.

The core teaching philosophy is experiential, learner-centric and inquiry-based to develop the mind-set, reflexes, agility and resilience an entrepreneur needs to search for certainty in the chaotic world of start-ups. This will be achieved with the adoption of several teaching aids and stress on the need to *get out of the classroom* to bring their businesses to life.

BUSA 401_B Entrepreneurship 2
Capstone option for BA, MIS, CS
Prerequisite: Entrepreneurship 1
Offered: Spring
Course Type: Seminar, Experiential
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1 Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

Capstone Entrepreneurship II will aim to aid venture teams validate their business models by undertaking further customer and stakeholder engagements, as well as MVP tests. This will help the teams further validate their product-market fit and gain some early adopters/ earlyvangelists to patronize their products/ services and pay for them. Feedback from these earlyvangelists will inform further iterations and pivots. Venture teams will then be taken through the Customer Creation and Company Building aspects of the Customer Development process. These form the *execution* aspect of the Customer Development process. The student will look at their product/ service positioning considering the market type they are entering, and then plan to launch their venture or its product/ service. Due to time constraints, strategies for reaching mainstream customers and company building, with a focus on structuring fast response departments will be put in place to aid in the executing this business model but will not be executed as a requirement of this session. Specifics include venture ownership, resource management, operations, and some management and cultural issues.

BUSA 402 Business Law
Required for all BA majors
Prerequisite: none
Offered: Fall
Course Type: Lecture, Experiential

Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1 Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

The goal of the course is to familiarize students with the legal environment within which business is conducted in Ghana and Internationally.

It is recognized that students undertaking this course are not being trained to be lawyers. However, the basis of all business activity is underlined by rules and regulations and for that matter, laws.

It is therefore essential that a student of Business Law appreciates rudiments or has a basic understanding of the legal framework governing businesses in Ghana.

BUSA 405 Competitive Strategy
Required for all BA & MIS majors
Prerequisite: Introduction to Finance or Finance for non-Finance Managers; Macroeconomics; Prior or concurrent enrollment in Marketing recommended but not required.
Offered: Spring
Course Type: Lecture
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1 Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

Organizations have always had to find ways of staying in business and more importantly thriving in their chosen markets. This requires the development, implementation and evaluation of business strategy. Competitive Strategy also known as business strategy is designed to establish a profitable and sustainable advantage and position for a business in a preferred marketplace.

Although knowledge from such disciplines as Marketing and Human Resource Management are important in managing a business, this course will focus on the role competition plays in business strategy development and implementation i.e. understanding the organization and competitive environment in which a firm operates, formulating long-term direction, determining how to position a business unit, as well create a sustainable competitive advantage within a competitive environment, mobilizing resources and developing capabilities to compete and assessing performance.

BUSA 410 Applied Project
Capstone option for BA, MIS, CS
Prerequisite: 8 Credits in Major Area of Study
Offered: Fall & Spring
Course Type: Seminar
Ashesi Units: 1; Credit Hours:3; Hours per week classroom: 1.5; Hours per week discussion: n/a Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 10 per week)

The Applied Project is characterized by its engagement with a real-life organization. Ultimately, students are expected to integrate foundational knowledge and skills gained over time and use them to solve real-life challenges for existing organizations. The successful execution of an Applied Project requires skills sets including research and critical analysis; stakeholder engagement; project management; professionalism and communication.

The student must be committed to the three pillars of Ashesi, and as a true **scholar**, be able to apply rigorous research and analytical skills to a real-life challenge; as a **leader**, be able to demonstrate excellent self-leadership and problem-solving skills, all executed in a professional manner; as a good **citizen**, seek to help an organization to create value and contribute to the body of knowledge on the selected subject

matter. Click here to view the applied project handbook. Send an email to sagyepong@ashesi.edu.gh if you have any questions about the BA Applied Project.

BUSA 422 Corporate Finance
Required for all BA majors
Prerequisite: Investments Offered: Spring & Summer
Course Type: Lecture
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1 Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

This course covers numerous issues of practical relevance to the contemporary corporate finance manager. Although the central focus will be on how corporations make investment and financing decisions, the introductory classes will discuss households' saving and investment decision-making and how securities markets and financial intermediaries complement such efforts. Topics to be covered include risk and return, asset valuation, working capital management, mergers and acquisitions, and corporate restructuring. The course focuses on the application of corporate finance concepts to solving real life problems in a typical business environment. Students will learn to appreciate how the timing of and uncertainty about future cash flows and their associated risks combine to determine the current value of those cash flows. It is expected that assignments, class projects, and discussions will provide the needed motivation and enhance students' understanding of the finance theories to be discussed. The numerous real-life examples and cases are aimed at equipping the students with skills to plug-and-play in a starting finance position in any organization in Ghana and abroad.

BUSA 423 International Finance
Major Elective for BA, MIS. Non-Major Elective for ENG and CS
Prerequisite: Introduction to Finance
Offered: Typically offered in the Spring
Course Type: Lecture, Experiential
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1 Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

This is an introductory course aimed at equipping students with the basic skills of corporate finance. In this course, students will be introduced to some fundamental principles of corporate finance such as time value of money and risk. Specific areas of concentration include the time value of money, investment valuation and decision making under conditions of certainty and uncertainty, working capital management, capital budgeting, cost of capital, capital structure and dividend policy, and intermediate and long-term financing.

BUSA 430 Human Resource Management
Major Elective for BA, MIS. Non-Major Elective for ENG and CS Prerequisite: Organizational behavior
Offered: Typically offered in the Fall
Course Type: Lecture
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1 Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

The purpose of this course is to familiarize you with the basic principles and techniques of human resource management. The course takes a practical view that incorporates the contributions of the behavioral sciences with the technical aspects of implementing the HR function in the 'real world.'

Surely, not everyone who takes this course will become a human resource professional, although that individual will learn a great deal about those roles. However, all managers, no matter what their specializations are, play essential roles in carrying out HR policies and practices in their organizations. Consequently, a basic understanding of human resource management (HRM) is essential wherever you find yourself in your world of work. The key objective of this course is to enable you learn that HRM is more than just accepting employment applications and keeping records. It is a central and strategic organizational activity of increasing complexity and importance.

BUSA 431 Real Estate Development

Major Elective for BA, MIS. Non-Major Elective for ENG and CS
Prerequisite: Quantitative Methods or Statistics for Engineering & Economics
Offered: Typically offered in the Fall
Course Type: Lecture, Experiential
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1 Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

The real estate development course aims to introduce students to what real estate development (RED) is and what the development process entails. It seeks to provide students with a good overview of what goes into the various stages of the development process with emphasis on feasibility studies, financing and management. This year, the class will undertake a feasibility study for a real-life client. This client needs a feasibility study conducted for a development they want to embark on. The outputs expected are a feasibility report and recommendations for financing and property management, post development. Students in the class will be split into teams to conduct the study, going through the 8-stages of the development process. They will do this as they are taken through the various stages of the development process in the class, visit the site and also interact with professionals who will help them make development and investment decisions for the client. The bottom line is a development which is sustainable where its financial model is concerned, and one that is environmentally considerate.

BUSA 442 Strategic Brand Management

Major Elective for BA, MIS. Non-Major Elective for ENG and CS
Prerequisite: Marketing and Text & Meaning; or Foundations of Design & Entrepreneurship II Offered: Typically offered in the Fall
Course Type: Lecture
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1 Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

The course is designed to develop students' marketing skills and understanding of brand management. In this course, you will learn how to make branding decisions, develop a strategic brand plan & manage brands by learning & applying relevant concepts, principles, & theories. By the end of this course, you should be able to:

- Understand the strategic brand management process and role of brand management in achieving business success.
- Have an in–depth appreciation and understanding of the important issues in planning, implementing and evaluating brand strategies.
- Grasp appropriate concepts, theories, models and other tools to make better branding decisions.
- Apply branding principles to cases and opportunities created by the course.

- Develop brand positioning, strategic brand plans and integrated marketing communications plans to grow brands.

BUSA 444 Supply Chain Management
Major Elective for BA, MIS. Non-Major Elective for ENG and CS
Prerequisite: Quantitative Methods; or Statistics for Engineering & Principles of Economics
Offered: Typically offered in the Fall
Course Type: Lecture
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1 Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

This course presents the fundamental concepts and tools needed to understand how Supply Chains work. The content spans the typical scope of supply chains: Plan, Source, Make, Deliver and Sell set in today's global market in which there is fierce competition, more frequent innovation and more sophisticated and demanding customers/consumers. Continuous advances in technology also provide a wide variety of continuous improvement options in supply chains. The interactions of the factors and levels of supply chains are explored for optimization and efficiency in Supply Management, Inventory Management, Product & Production Management, Distribution and Transportation Management. The Course also covers the Responsible Sourcing and the Key Performance Indices that are used to determine service levels and efficiencies in supply chains.

BUSA 451 Development Economics
Major Elective for BA, MIS. Non-Major Elective for ENG and CS
Prerequisite: Micro-economics or Macro-Economics or Principles of Economics; and Statistics
Offered: Typically offered in the Fall
Course Type: Lecture
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1 Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

This course discusses the problems of Least Developed Countries (LDCs) and Middle-Income countries (especially in Africa, Asia and Latin America) and their efforts to improve the lives and well-being of their people. It incorporates different aspects of the development process including traditional development topics like economic growth; education; population studies; rural-urban migration and poverty studies as well as less traditional but equally pertinent topics like institutions; competition policy; foreign aid and corruption. The principal objective of the course is to develop the student's ability to master and apply the tools of economic theory and analysis to contemporary challenges in economic development.

ECON 101 Micro-Economics
Required for all BA, MIS Majors. CS & ENG majors can substitute Principles of Economics with this course.
Prerequisite: Pre-Calculus 2 or Calculus 1
Offered: Fall or Summer
Course Type: Lecture
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1 Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

The aim of the course is to introduce students to the fundamental principles, ideas, theories and tools of microeconomic theory. At the end of the course students should have achieved some understanding of and gained competence in using economic ideas, tools and procedures.

ECON 102 Macro-Economics
Required for all BA & MIS majors Prerequisite: Pre-Calculus 2 or Calculus 1
Offered: Spring or Summer
Course Type: Lecture
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1 Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

This course is an introduction to macroeconomics, with a strong emphasis on policy implications. The course has two objectives. Firstly, it will develop simple models of goods and services, assets, capital and money markets which can be usefully applied to generate realistic predictions regarding the behavior of macroeconomic variables such as: output; employment; inflation; the current account; and interest and exchange rates. Secondly, the course will teach students to use these models to understand and interpret current and historical macroeconomic developments. Current macroeconomic developments and policy changes such as the financial and banking crisis, inflation targeting, austerity measures, deficit financing among others will be discussed.

ECON 452 Econometrics
Major Elective for BA, MIS. Non-Major Elective for ENG and CS
Prerequisite: Micro-economics or Macro-Economics or Principles of Economics; and Statistics and Quantitative Methods (Multi Variable Calculus can replace Quant Methods as a prerequisite for this class)
Offered: Typically offered in the Fall
Course Type: Lecture
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1 Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

The objectives of the course are the following:

- Introduce students to techniques for performing statistical analysis on quantitative data focusing on the estimation of the regression model.
- Help students solve problems commonly encountered in estimating statistical models like the regression model.
- Teach students to interpret the estimates from such models.
- Enable students to be able to perform quantitative analysis using secondary data.

Please note: The course is ideal for current Ashesi seniors and juniors interested in the analysis of quantitative (as opposed to qualitative) data.

ECON 455 Managerial Economics
Major Elective for BA, MIS. Non-Major Elective for ENG and CS
Prerequisite: Calculus 2 or Applied Calculus; Micro-economics; Macro-economics; Statistics or Econometrics
Offered: Typically offered in the Spring
Course Type: Lecture
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1 Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

Managerial Economics is the study of the different ways in which economic principles and quantitative tools can be employed to assist managers to make effective decisions. It provides principles to foster the goals of the organization, as well as a better understanding of the external business environment in which an organization operates. The course enhances students' understanding of how markets operate and develops their capability to make economic predictions about market outcomes.

SOAN 325 Research Methods
Required for all BA, MIS & CS Majors
Prerequisite: Statistics
Offered: Spring
Course Type: Lecture
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1 Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

The course is designed to provide the student with broad fundamentals of research methods. To this end, students will be introduced to quantitative, qualitative and mixed methods approaches for conducting research. Students will be guided through the various stages of conducting research; i.e. writing research proposals, where they will identify problems to study; collecting information by conducting appropriate literature review; collecting appropriate primary and/or secondary data; analyzing data; writing mini reports; and critiquing published articles. Class time will be devoted to lectures, data analysis and in-class assignments. The course is hands-on, using R as the main software.

ENGR 413 Project Management & Professional Practice
Major Elective for BA, MIS. Non-Major Elective for ENG and CS
Prerequisite: Operations Management
Offered: Typically offered in the Fall
Course Type: Lecture
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1 Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

This course will expose students to planning, strategizing and executing a project in their field of study or in another field, while engaging the cross section of talent in the class: engineering, computer science, management information systems and business administration students. It will develop students' skills to manage projects and build on leadership skills and ethical reasoning they have acquired in core courses. Students will learn about organizational, environmental, safety and health issues that must be considered during the implementation of a project. Students will also learn, discuss, and reflect on professional issues such as social responsibility, ethics, licensing, and regulatory reporting. They will be introduced to Industrial Engineering, process management, work measurement, capacity utilization and constraints management. Hinged on the PMI® Framework for Project Management and using the PMBOK® Guide as the core text, students will network and interact with members of the PMI-Ghana Chapter as they will be recognized as student members for the year. Interested students will also be supported to prep for the CAPM® Certification to enhance their employability after they graduate from Ashesi.

BUSA 424 Venture Capital Investment
Major Elective for BA, MIS. Non-Major Elective for ENG and CS
Prerequisite: TBD
Offered: Typically offered in Fall

Course Type: Lecture
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1 Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

The course expands on the entrepreneurial skills, cash flow appraisal techniques, investing decisions, and financing decisions learned in the prerequisite courses to the structuring of a venture capital (VC) fund, raising VC funds, appraisal of entrepreneurial ventures, allocation of funds to good entrepreneurial ventures, and support for entrepreneurs through the value generation process to the exit point. Students will learn that VC is not just another financing vehicle, but a business building endeavor pursued by the venture capitalist in strict partnership with the entrepreneur to facilitate and accelerate the success of the entrepreneur. The course asks three pertinent questions: What is an attractive sector to allocate VC funds to? Is the entrepreneurial venture a good one? Will allocation of funds to the entrepreneurial venture allow relevant stakeholders to achieve their return goals? The course will provide students with the knowledge and skills needed to answer those questions through lectures, case studies, testimonials from industry, group discussion, and role play.

BUSA 432 Organization Development
Major Elective for BA, MIS. Non-Major Elective for ENG and CS
Prerequisite: FDE 1
Offered: Spring
Course Type: Lecture, Experiential
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1 Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

How can the outcome of capstone applied projects help organizations assess themselves and their environments, leading to the revitalization and rebuilding of their strategies, structures and processes for competitive advantage? What influence tactics can student consultants employ to gain trust from organizations for them to open their doors for them to study their systems for improvement? This course is designed to build the capacities of students who desire to undertake capstone applied projects that contribute towards the effectiveness of organizations.

The course is Organization Development (OD) Consulting in orientation, with a focus on the systematic application and transfer of behavioral science knowledge to the planned development, improvement, and reinforcement of the strategies, structures and processes that lead to organizational effectiveness. It pays attention to the practical resolution of organizations' problems systematically under changing environments, organizational behavior which impacts on its development, techniques or tools that use authentic data to identify and address organizations' problems and obstacles that inhibit their growth.

BUSA 441 Service Marketing
Major Elective for BA, MIS. Non-Major Elective for ENG and CS
Prerequisite: Quantitative Methods; or Statistics for Engineering & Principles of Economics
Offered: Typically offered in the Fall
Course Type: Lecture
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

Growing number of school graduates are recruited in service industries. This is because the service sector as a percentage of Gross National Product is substantial and has grown significantly in most countries including Ghana. However, teaching of Marketing in tertiary institutions tends to focus largely on manufacturing or product-based models of business practice which are not always adequate or even in

some cases not very useful in making decisions in a service business. The Services Marketing course seeks to teach students the concepts, frameworks and analytical procedures that are best suited to examine and resolve challenges faced by managers and as well as develop successful and coherent marketing strategy/plan for service products.

BUSA 471 Social Enterprise
Major Elective for BA, MIS. Non-Major Elective for ENG and CS
Prerequisite: FDE, Micro-Economics
Other courses that complement this course include Marketing; Corporate Finance; Operations Management; Competitive Strategy; Investments; Economic Development; Branding; New Product Development; Strategic Brand Management; and *Service Marketing.*
Offered: Typically offered in the Spring
Course Type: Lecture, Experiential
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

Social Enterprise is an exploratory business elective offered by the business administration department that challenges the student to think in ways that produce sustainable and profitable outcomes that lead to social or environmental impact. Through various team challenges, assessments, and meet the leader sessions students have the opportunity to discuss, examine, and transfer thought into action as they work together to come up with their own solutions for some of their world's toughest challenges.

CS221 Discrete Structures and Theory

Prerequisites: Pre-Calculus 2 or Calculus 1, Introduction to Computing & Information Systems OR Computer Programming for CS OR Computer Programming for Engineering
Ashesi Units: 1; Credit Hours: 4.5; Hours per week classroom: 3; Hours per week discussion: 1.5
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 9 per week)

This course is designed to give students in Computer Science the mathematical foundations they need for their future studies. Specifically, you will learn:

- Mathematical reasoning: how to think logically and mathematically? Understanding and constructing proofs.
- Combinatorial analysis: to be a problem solver, it is important to be able to count objects. We will see some basic techniques for counting.
- Discrete structures: of course, as the name of the course suggests, you will also learn how to manipulate discrete structures (sets, permutations, relations, graphs…).
- Algorithmic thinking: sometimes, we will solve a problem by specifying a list of steps to follow (an algorithm). Algorithms can be implemented through computer programs. By the end of this course, you will know how to describe algorithms (in both English and pseudocode), verify that they work properly, analyze the computer memory and time required to implement them.
- Applications and modeling: applications to show the relevance and practicality of mathematics. We will see applications of discrete mathematics to computer science, data networking and biology. An important problem-solving skill is the construction of mathematical models. We will build our own models while solving some of the exercises.

CS222 Data Structures & Algorithms

Prerequisites: C or better in EITHER Computer Programming for CS OR Computer Programming for Engineering; Concurrent enrolment in Discrete Structures and Theory recommended but not required
Ashesi Units: 1; Credit Hours: 4.5; Hours per week classroom: 3; Hours per week discussion: 1.5
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 9 per week)

This course is about data structures; that is the methods of organizing large amounts of data. It is also about algorithm analysis; that is, the estimation of the running time of algorithms. Specifically, this course will cover fundamental abstract data types and their implementations as data structures, such as lists, hash tables, trees, priority queues, and graphs, as well as asymptotic analyses of algorithms involving these data structures. Students will also learn about recursion, searching (sequential and binary); and sorting (selection sort, insertion sort, merge sort, and heap sort). The Java programming language will be used as the language of implementation in this course, and so Eclipse or IntelliJ will be the recommended development environments.

Course Objectives: At the end of this course, students will be able to:

- Analyze and compute the running time of algorithms, expressing these runtimes using asymptotic notation (Big-O).
- Explain and implement a variety of linear and non-linear data structures.
- Explain and implement fundamental algorithms for searching and sorting.
- Identify and apply appropriate data structures for the solution of practical problems.

CS313 Intermediate Computer Programming
Prerequisites: EITHER Computer Programming for CS OR Computer Programming for Engineering
Ashesi Units: 1; Credit Hours: 4.5; Hours per week classroom: 3; Hours per week discussion: 1.5
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 9 per week)

This course is a continuation of Computer Programming for CS. It will introduce students to more details of object definition and construction and event-driven programming. It will also introduce additional standard Java packages, including the file system and graphical user interface elements. This course will also give students an introduction to C++. Good software engineering practices will be featured in various aspects of the course, and notations like the Unified Modeling Language (UML) will be employed. Through one or more team projects, students will gain experience in designing and implementing larger systems. However, the emphasis of the course will be on the use of prewritten packages and built-in language facilities, as well as design and implementation of moderately sized custom classes and algorithms, rather than on the design of whole systems.

CS 314 Human Computer Interactions
Prerequisites: Introduction to Computing & Information Systems OR Computer Programming for CS OR Computer Programming for Engineering
Ashesi Units: 1; Credit Hours: 4.5; Hours per week classroom: 3; Hours per week discussion: 1.5
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 9 per week)

This course is an introduction to Human Computer Interaction (HCI), a discipline concerned with the design, evaluation, and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them. The course considers the inherently multi- and interdisciplinary nature of HCI and situates various HCI issues in the organizational and societal contexts. It introduces theories of human psychology, principles of computer systems and user interfaces designs, a methodology of developing effective HCI for information systems, and issues involved in using technologies for different purposes.

Learning Objectives: At the end of this course, the student should be able to:

- Explain HCI and interaction design to non-experts
- Describe cognitive foundations of HCI and user centered design process
- Gather and understand user requirements
- Design and evaluate UI of low and medium complexity
- Communicate effectively about design and evaluation
- Discuss some of the outstanding research problems in HCI.

CS331 Computer Organization and Architecture
Prerequisites: EITHER Computer Programming for CS OR Computer Programming for Engineering. Completion or concurrent enrollment in Discrete Structures and Theory.
Ashesi Units: 1; Credit Hours: 4.5; Hours per week classroom: 3; Hours per week discussion: 1.5
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 9 per week)

This course presents the fundamental concepts of computer organization and instruction set architectures. Assembly language programming is used to present and illustrate the concepts of instruction set design. The basics of Central Processor Unit (CPU) design and implementation are covered, including some performance enhancing methods like pipelining and memory caches. The interface to the Compiler and Operating System is described in terms of the interaction between the hardware and software

components of a system. The course discusses developments in modern computer system such as parallel processing, virtual computing and other new architectures.

Course Objectives:

- Learn digital system design process
- Understanding of modern computer architecture
- Understand Software-Hardware interface
- Understand low level programming and program execution

CS341 Web Technologies
Prerequisites: Computer Programming for CS OR Computer Programming for Engineering, Completion or concurrent enrollment in Database Systems
Ashesi Units: 1; Credit Hours: 4.5; Hours per week classroom: 3; Hours per week discussion: 1.5
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 9 per week)

This course introduces the World Wide Web Consortium (W3C) standard markup language and services of the Internet. Topics covered will include basic and advanced HTML, scripting and active pages, design and active pages, design and developing Web-based applications, principles and tools for Web content creation, database fundamentals for the Web, Web management, and Web service delivery. The primary goal of this course is to introduce the relevant technologies and skills needed to design, develop, deploy and manage effective Web Applications. To achieve this goal, we will use a set of 'programming languages': HTML, CSS, JavaScript (AJAX, jQuery, Frameworks or Libraries), PHP, MySQL (relational database management system) and Content Management Systems (CMS).

CS415 Software Engineering
Prerequisites: EITHER Computer Programming for CS OR Computer Programming for Engineering, EITHER Web Technologies OR Intermediate Computer Programming OR Data Structures
Ashesi Units: 1; Credit Hours: 4.5; Hours per week classroom: 3; Hours per week discussion: 1.5
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 9 per week)

This course will introduce a collection of methods which embody an "engineering" approach (i.e., scientific method) to the development of computer software. The content starts with development lifecycle models, such as waterfall, agile development, etc. and then continues to cover requirements specification, the Unified Modelling Language (UML), software architecture, object-oriented analysis and design, design patterns and testing.

Software engineering is an inherently practical subject and applying the concepts being taught is a vital component of developing expertise in this area. Consequently, students undertake a substantial group project, working through a number of stages of the development of a (larger) software application. Students will be supervised but will be expected to largely organize themselves and their work, learning key transferable skills in management and organization.

Learning Objectives

- Appreciate the wider engineering issues that form the background to developing complex and evolving software-intensive systems.
- To understand principles, concepts, methods, and techniques of the software engineering approach to producing quality software.
- To organize and manage a medium-sized software development project, including project plans and documentation, and schedule.

- To make effective technical oral and written presentations.
- Plan and deliver an effective software engineering process, based on knowledge of widely used development lifecycle models.
- Employ group working skills including general organization, planning and time management and inter-group negotiation.
- Capture, document and analyze requirements.
- Translate a requirements specification into an implementable design, following a structured and organized process.
- Make effective use of UML, along with design strategies such as defining a software architecture, separation of concerns and design patterns.
- Formulate a testing strategy for a software system, employing techniques such as unit testing, test driven development and functional testing.
- To think critically about ethical and social issues in software engineering.

CS424 Advanced Database Systems

Prerequisites: Database Systems, EITHER Discrete Structures and Theory OR Data Structures and Algorithms

Ashesi Units: 1; Credit Hours: 4.5; Hours per week classroom: 3; Hours per week discussion: 1.5

Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 9 per week)

Advanced Database Management Systems course deals with the usage as well as concepts of design and architecture of databases. In covering the concepts, theorems and algorithms, proofs relevant to different aspects (design, architecture, and implementation) are covered. The general approach is to go through design, architecture (schema, indexes, and storage), core features (transactions, concurrency), and specialized database usage (data mining & data-warehousing). The practical work done in the course goes through usage of some advanced SQL features and the implementation of some algorithms and coding of internals of an actual database system.

Students should already know structured query language. The course will build further on this to include concepts such as union types and predicates. The diagram format for design may change a bit but it provides students more expressivity for their designs.

Course Objectives:

- To be competent with conceptual and logical database design
- To be able to setup and configure Enterprise DBMS.
- To be able to create and use database objects such as tables, views, stored procedures, functions, indexes, constraints and triggers.
- To be able to design and develop a holistic and efficient database for any system.
- To be able to modify data with logical query processing.
- To be able to troubleshoot and optimize database using tools to analyze query performance.

CS435 Operating Systems

Prerequisites: EITHER Computer Programming for CS OR Computer Programming for Engineering, EITHER Discrete Structures and Theory OR Data Structures and Algorithms

Ashesi Units: 1; Credit Hours: 4.5; Hours per week classroom: 3; Hours per week discussion: 1.5

Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 9 per week)

This is a course on theory and practices of operating system design and implementation. Operating Systems are found in most computing devices we use (e.g., mobile phones, tablets, laptops, televisions, cloud); some are embedded, some are general purpose or specialized –anywhere you find computing, you will find an operating system. All operating systems deal in some way or another with users, security, resources, storage and memory, threads and processes, scheduling, as well as policies associated with or built on these. Our course covers an overview of operating systems, processes, memory, I/O management, file systems and some case studies.

Course Objectives: Upon completion of this course, the students should be able to:

- Explain the concepts, structures, and mechanisms of modern operating systems.
- Design a concurrent system without deadlock.
- Write concurrent programs using multiple threads and processes.
- Describe process execution using various CPU scheduling algorithms.

CS442 E-Commerce
Required for MIS, Elective for CS
Prerequisites: Database Management Systems and Web Technologies
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 4

This is an introduction to e-Commerce principles, technologies, and applications. This course also develops understanding of the problems and requirements of Internet business, and the corresponding solutions. Protocols to ensure secure transactions and e-commerce protocols based on encryption techniques will also be studied. Legal and ethical issues will be discussed, as well as marketing and revenue models for online businesses. Students will get hands on experience building a secure ecommerce site.

Course objectives:

- Students will be able to build an ecommerce application that is secure and uses best practices.
- Students will understand the legal and ethical issues involved in e-commerce.
- Students will understand infrastructure and technology options for setting up an ecommerce site and will have experience deploying some of them.
- Students will be able to determine appropriate revenue models for an online business.

CS452 Machine Learning
Prerequisites: Computer Programming for CS OR Computer Programming for Engineering, Multivariable Calculus & Linear Algebra
Ashesi Units: 1; Credit Hours: 4.5; Hours per week classroom: 3; Hours per week discussion: 1.5
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 9 per week)

This course introduces machine learning. Topics include supervised and unsupervised machine learning, statistical inference and prediction. A wide variety of algorithms will be presented, including logistic regression, K-nearest neighbors, naïve Bayes, decision trees, neural networks, K-means, mixtures of Gaussians, principal components analysis, Expectation Maximization. The course will also discuss modern applications of machine learning such as image segmentation and categorization, speech recognition, and text analysis.

Course Objectives:

- To understand and be able to explain the foundational principles underlying the field of machine learning

- To be able to implement algorithms for regression, classification, clustering and dimensionality reduction
- To be able to design suitable machine learning models for a given real-world problem.
- To be able to read and understand machine learning research papers.
- To be able to give presentations on machine learning work to technical and non-technical audiences.

CS 453 Robotics

Prerequisites: EITHER Computer Programming for CS OR Computer Programming for Engineering; EITHER Calculus II OR Applied Calculus
Ashesi Units: 1; Credit Hours: 4.5; Hours per week classroom: 3; Hours per week discussion: 1.5
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 9 per week)

This course gives a practical hands-on as well as theoretical introduction to robotics as a field that integrates expertise in Computer Science, Engineering, Design and Mathematics to create innovative systems that interact with and can operate autonomously or semi-autonomously in the physical world. In this course, students will work individually and in groups to implement robotics projects using robotics platforms such as the Lego EV3 kits, the TurtleBot robot, Interbotix robot arm, among others.

Course Objectives: To understand and be able to explain the foundational principles underlying the field of robotics.

- To be able to integrate sensors, actuators, and software into a robot designed to undertake some tasks.
- To be able to implement algorithms for planning and other functionality on robots.
- To be able to read and understand robotics research papers.
- To be able to give presentations on robotics work to technical and non-technical audiences.

CS458 Internet of Things

Prerequisites: Computer Programming for CS OR Computer Programming for Engineering
Ashesi Units: 1; Credit Hours: 4.5; Hours per week classroom: 3; Hours per week discussion: 1.5
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 9 per week)

The Internet of Things (IoT) course takes an end-to-end view of IoT including the devices, networks, data analytics, programming, security, and business. It exposes the student to all aspects of a functional IoT system and how to design a secure, robust and scalable IoT network, taking on a hands-on approach. Labs and small projects will be used to gain understanding of key concepts at the various layers. Key among these are the devices, network protocols, data and programming aspects. Students will review hardware types and software tools and be introduced to IoT design principles which cover how to transition from an IoT idea to an IoT product, building of prototypes and commercializing them. Since IoT is still emerging, businesses are going to be either adopting IoT solutions or transforming their existing businesses to include IoT in a seamless and sustainable manner. The course addresses these aspects as well, in order to prepare participants to lead in this budding industry in the business segment.

CS459 Natural Language Processing

Prerequisites: Computer Programming for CS OR Computer Programming for Engineering
Ashesi Units: 1; Credit Hours: 4.5; Hours per week classroom: 3; Hours per week discussion: 1.5
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 9 per week)

This course seeks to introduce students to basic and foundational concepts in natural language processing. The course will use three NLP tasks – sentiment analysis, machine translation and conversational systems – to concretize these concepts. The course will be project based and students will be expected to draw connections between the concepts they learn and the projects they are assigned. Students will be expected to communicate their thought process and solutions. It won't be enough to write code that 'works': students must show they know and understand what they are doing.

Course Objectives:

- To understand basic and foundational concepts in language processing.
- To understand what goes into developing sentiment analysis programs, conversational agents and machine translation systems.
- To be able to write sophisticated programs to perform sentiment analysis.
- To think through and develop ideas and resources for translation systems for native African languages.
- To be able to read, understand and apply selected research papers in NLP.
- To be able to give presentations on NLP work to technical and non-technical audiences.

IS331 IT Infrastructure

Prerequisites: Computer Programming for CS OR Computer Programming for Engineering
Ashesi Units: 1; Credit Hours: 4.5; Hours per week classroom: 3; Hours per week discussion: 1.5
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 9 per week)

This course introduces IT Infrastructure as a shared technology resource for students majoring in Management Information Systems. It covers topics related to both computer and systems architecture and communication networks, with an overall focus on the services and capabilities that IT Infrastructure solutions enable in an organizational context. It gives the students the knowledge and skills that they need for communicating effectively with professionals whose special focus is on hardware and systems software technology and for designing organizational processes and software solutions that require in-depth understanding of the IT Infrastructure capabilities and limitations. The course focuses strongly on Internet-based solutions, computer and network security, business continuity, and the role of Infrastructure in regulatory compliance.

Course Objectives: Upon completion of this course, the students should be able to.

- Understand the principles underlying layered systems architectures and their application to both computers and networks.
- Understand the differences and similarities between the core elements of an IT Infrastructure solution, such as clients, servers, network devices, wired and wireless network links, systems software, and specialized security devices.
- Understand how IT Infrastructure components are organized into Infrastructure solutions in different organizational environments.
- Understand through practical examples how protocols are used to enable communication between computing devices connected to each other.

IS332 System Administration Lab

Prerequisites: Computer Programming for CS OR Computer Programming for Engineering; Prior or concurrent enrolment in IT Infrastructure, Operating Systems or Networks and Data Communications is recommended

Ashesi Units: 1; Credit Hours: 4.5; Hours per week classroom: 3; Hours per week discussion: 1.5
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 9 per week)

This course builds on the theory and practice developed in the IT Infrastructure course, with in-depth experience in configuring and administering IT infrastructure, particularly operating systems, networks, network devices, and security solutions. It provides both conceptual knowledge and practical experience. It also prepares the students for organizational roles that require interaction with external vendors of IT infrastructure components and solutions. Topics of discussions, assignments and lecture time shall include, but not limited to server architectures, authentication and security, network services including firewalls, storage services, performance analysis and tuning, management and configuration of services and system resources, system initialization, cross-platform services, policies and procedures.

Course Objectives: After successful completion of this course, students will be able to:

- Configure an IT infrastructure solution for a small organization, including a network based on standard technology components, servers, security devices, and several different types of computing clients.
- Identify potential sources of poor computer performance and evaluate potential solutions.
- Evaluate alternative policies and mechanisms for providing reliability features of computer system services and operations.
- Apply the core concepts underlying IP networks to solve simple network design problems, including IP planning.
- Configure simple infrastructure security solutions.
- Negotiate with vendors providing design and implementation solutions.
- Cloud Computing.

IS451 Information and Systems Security

Prerequisites: Discrete Structures; Computer Programming for CS OR Computer Programming for Engineering
Ashesi Units: 1; Credit Hours: 4.5; Hours per week classroom: 3; Hours per week discussion: 1.5
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 9 per week)

Information security mechanism is one of the most crucial factors for any organization. Important assets of organization demand a proper risk management and threat model for security hence, information and systems security concepts are gaining a lot of traction. This course will initially cover the concept of information and systems security and software installations process. It will then move on to modules such as threat modelling, risk management and mitigation.

This Course covers the network as well as web scanning. Later in the course it teaches how to use Kali Linux for ethical hacking, it will have different practical sessions on using Kali Linux such as for information gathering, vulnerability analysis, web application analysis, database assessment and password attacks and have some hands-on experience. It will also cover concepts of incident response system, information rights management and so on. It will then guide you towards building your own information security framework best fit for an organization. At the end of this course, you will be well versed with all the factors involved with information security which would help you build a security framework which will be perfect fit for an organizational requirement.

Mathematics Track – Mathematics courses taken by various majors at Ashesi are housed in the Computer Science Department

MATH101 College Algebra
Prerequisites: None
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week lab: 1
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

The goal of this course is to help freshmen develop a good knowledge of basic mathematical principles. Because the best way to learn mathematics is to do mathematics, classes will include a lot of meaningful activities through which students will build mathematical intuition, effective problem-solving skills, and discover real-world applications of mathematics.

MATH121 Pre-Calculus 1
Prerequisites: None
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week lab: 1
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

One definition of mathematics is the science of patterns. Patterns are all around us and the human brain is wired to recognize them. Pre-calculus uses the formal concept of functions to identify and describe patterns found in data, patterns expressed as a formula, and patterns identified visually in a graph. The emphasis of the course is on developing a conceptual understanding of the definition of a function, the characteristics of important function families, connections to real life, and how the study of functions facilitates the understanding of calculus. A focus on problem solving strategies, such as drawing diagrams, systematic lists, looking for patterns, matrix logic, unit analysis, estimation, and others, further develop students' skills in quantitative reasoning.

MATH122 Pre-Calculus 2
Prerequisites: Pre-Calculus 1
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week lab: 1
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

One definition of mathematics is the science of patterns. Patterns are all around us and the human brain is wired to recognize them. Pre-calculus uses the formal concept of function to identify and describe patterns found in data, patterns expressed as a formula, and patterns identified visually in a graph. The emphasis of the course is on developing a conceptual understanding of the definition of a function, the characteristics of important function families, connections to real life, and how the study of functions facilitates the understanding of calculus. A focus on problem solving strategies, such as drawing diagrams, systematic lists, looking for patterns, matrix logic, unit analysis, estimation, and others, further develop students' skills in quantitative reasoning.

Students Learning outcomes

Mastery of algebra fundamentals.

- Conceptual understanding of functions, including the linear, polynomial, rational, radical, exponential, logarithmic, periodic and related function families, their applications and various forms of representation, such as graphic, symbolic, and tabular forms.
- Ability to apply a problem solving heuristic and appropriate strategies to a wide range of novel and challenging application, logic and quantitative reasoning problems, and present solutions using proper notation and clear communication.

Instructional Objectives

- Content will be presented in a clear and intuitive way using a variety of activities and applications to deepen student understanding and appreciation of functions.

MATH141 Calculus 1
Prerequisites: None
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week lab: 1
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

This course seeks to equip students with an intuitive idea of limits. We will discuss continuity and the derivative of a function. Rules of differentiation would be examined and applied. The derivative of the elementary and transcendental functions would be discussed. We would apply the taught theoretical concepts to solve real-life problems.

Course Objectives: The course is expected to expose students to the fundamentals of calculus.

MATH152 Statistics for Engineers
Pre-requisites: Engineering Calculus
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week lab: 1
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

This course is a calculus-based, mathematical introduction to the fundamental principles of probability theory, statistics, and applications. Topics include descriptive measures, the axioms and properties of probability, combinatorial analysis used in computing probabilities, conditional probability, independence of events, sampling theory, discrete and continuous random variables, the standard distributions, estimation and hypothesis testing, analysis of variance, regression and correlation, expected value and variance, joint distributions, distributions of a function of a random variable, and sampling distributions. Also included are theoretical results such as Bayes Theorem, Central Limit Theorem, Law of Large Numbers, the Empirical Rule, Hypothesis Testing and Confidence intervals at least for a single mean and a single proportion. Programming in R or a similar language will be used to gain experience with statistical analysis in practice.

MATH 161 Engineering Calculus
Required for CE, EE and ME students
Pre-requisites: none

This course equips students with knowledge of differential and Integral Calculus which is fundamental to the field of Engineering. The focus is three dimensional: Concepts, Methods and Applications. Technology such as graphing utility and GeoGebra will be used to aid concept building and solution process.

MATH211 Multivariable Calculus & Linear Algebra
Prerequisites: TBD
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week lab: 1
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

Physical problems require problem solving approaches which combine mathematical thinking and technology to develop modern solutions. Linear algebra and multivariable calculus is a course which provides the essential and foundational toolkit needed to approach such real-life problems. In this course,

you will build on your existing differentiation and integration of single variable studied in prerequisite courses and expand into multivariable calculus and linear algebra. Students will learn how to solve variety of equations in multi-dimensional spaces as well as study how to manipulate linear equations and vectors to solve some engineering problems.

MATH221 Statistics with Probability
Prerequisites: Pre-Calculus 2 or Calculus 1
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week lab: 1
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

What influences consumer choices? Why are some people healthier, academically more successful, or more athletic than others? Are you interested in understanding how climate change is impacting communities in your home country? How can the vast amount of data collected and stored online be used to improve our quality of life? The discipline of statistics seeks to turn data into useful information that can help answer these and many other questions that may pique your interest. In this course, learning statistics will be motivated by using real data to answer questions that YOU are passionate about. Each student will: (1) generate a testable hypothesis from real data; (2) understand how large datasets are structured; (3) format and manage data; (4) conduct descriptive and inferential statistical analysis; and (5) communicate the results of their research to expert and novice audiences. The process of converting data into useful information draws on the following statistical foundation skills taught in the course:

- Producing data
- Exploratory data analysis
- Probability
- Inference

Statistical computing software is the essential tool that ties the quantitative research process together. In this course, you will use R and R Studio to manage data, carry out statistical analysis, conduct simulations, and create graphs and charts to represent data visually – all in the service of answering your own interesting research question!

MATH233 Quantitative Methods
Prerequisites: Pre-Calculus 2 or Calculus 2 AND Statistics or Statistics for Engineering & Economics
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week lab: 1
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

This course will survey quantitative approaches to work in the business world. The course introduces students to concepts, techniques and software with which all successful managers should be familiar. The course has three main components: operation research/management science, project management, and statistics.

The course is hands-on, using spreadsheet techniques with minimal reference to complex or abstract mathematics and the R software. The statistical tests will be useful in nearly any senior project work, as well as any significant quantitative decision making in a business context.

Objectives:

1. To develop analytical and conceptual thinking skills.
2. To practice logical approaches to problem-solving.
3. To develop algebraic and spreadsheet modelling skills.
4. To be able to use the R software in solving statistical problems.

Learning outcomes

Upon successful completion of the course, students will be expected to:

1. Apply some commonly used Operational Research/Management Science (OR/MS) techniques.
2. Construct algebraic and spreadsheet models to inform business decisions.
3. Identify data requirements for typical OR/MS methods.
4. Implement models in Excel and interpret solutions from a managerial perspective.
5. Use the R software to solve statistical problems in multiple linear regression, time series analysis, binary logistic regression, etc.
6. Present a persuasive argument to peers about a business decision based on a mathematical model using appropriate data.

MATH 251 Differential Equations & Numerical Methods

Prerequisites: Multivariable Calculus & Linear Algebra, Applied Programming for Engineering or Computer Programming for CS

Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week lab: 1

Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

This course will introduce students to the topics associated with differential equations and applied numerical methods in solving engineering problems. Students will learn how to translate engineering problems into differential equations, develop MATLAB models and investigate different numerical methods to find solutions.

Using software, students will learn how to solve differential equations, find roots of equations, the method of gradient descent, discrete and continuous optimization, and finding the solution of linear equations using numerical methods. Techniques will be applied in a series of projects focused on engineering applications.

Topics: Analytic differential equations and modeling of engineering problems using differential equations; first order differential equations, systems of two first order equations, second order linear equations; homogeneous linear equations, nonhomogeneous equations; the existence and uniqueness of a solution, approximation; numerical solutions of linear equations, Euler and Runge-Kutta methods; root finding, gradient descent, discrete and continuous optimization; the Laplace Transform and Inverse Laplace Transform.

Engineering Core

ENGR 112 Introduction to Engineering

Required of CE, EE, and ME students
Prerequisite: Foundations of Design & Entrepreneurship 1 & 2
Ashesi Units: 1; Credit Hours: 5; Hours per week classroom: 3; Hours per week lab: 2
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 10 per week)

This course will introduce students to engineering by using practical problems and products from their surroundings. The course will challenge students to analyze the design and function of systems by using principles from different engineering fields including computer, electrical and electronic, and mechanical engineering. Students will study the contribution of material engineering, mechanical engineering, electrical and electronic engineering and computer engineering in making everyday objects, and the manufacturing processes needed for small and large-scale production. Students will also critically evaluate selected products from diverse perspectives: design/usability/utility, energy/environmental view, recyclability/waste/breakage, etc., to begin the conversation of the engineering profession's responsibility and contribution to society.

Topics: Design for engineering, case studies, engineering drawing and presentations, manufacturing process and methods, computer integrated manufacturing, safety in engineering, environmental impact and sustainability, topics in the profession of engineering.

Practical Sessions: CAD drawing using AutoCAD, assembling and disassembling products, practical skills in operating lab and field equipment, safety drills, basic design and implementation projects.

ENGR 212 Instrumentation for Engineering

Required of CE, EE, and ME students
Prerequisite: Statistics for Engineering and Economics, Physics I: Mechanics, and Physics II: Electromagnetism
Ashesi Units: 0.5; Credit Hours: 2; Hours per week classroom: 1; Hours per week lab: 1
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 4 per week)

This course continues the concept of measurement and measurement error that is introduced in the Physics sequence. Students study measurement systems, instruments, and measurement errors, and the use of probability and statistical analysis to design and execute experiments in the presence of measurement errors. An emphasis of the course is the design of instrumentation for experimental problem solving in real systems.

Topics: Survey of physical quantities typically measured, both physical and electrical. Analog signal conditioning for instrumentation. Measurement errors and implications on experimental design, planning, execution, and analysis. Parameters of sensors and transducers. Applications to process control and instrumentation (including pressure systems, temperature control, flow control, level control). Sensors appropriate to linear or angular acceleration, velocity, and position, DC and AC voltage, electrical resistance, capacitance or induction. DC null instrumentation such as Wheatstone Bridges.

Textbook: Robert Northrop, *Introduction to Instrumentation and Measurements, 2nd Edition*, CRC Press, 2005.

ENGR 300 Third Year Group Project and Seminar
Required of CE, EE, and ME students
Prerequisite: Leadership Seminar 4 for Engineers and System Dynamics, concurrent enrollment in Control Systems
Ashesi Units: 0.5; Credit Hours: 2; Hours per week classroom: 1.5; Hours per week lab/discussion: 2 (or more hours independent work)
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 10 per week)

In their third year, engineering students will participate in a one-year group project that ideally cuts across multiple engineering fields (electrical and electronic, mechanical and computer), to revisit the design process at a higher level, to deepen teamwork skills, and to reinforce system level thinking. Part 1 of the third-year project is implemented through *Leadership 4 for Engineers*, which will address leadership, service learning, and responsibilities of the engineering profession to the community. Projects undertaken will include a service-learning component. Students will consider more than technical feasibility in their solutions, but also the desirability and sustainability of their solution to the community and the environment. In the course Third Year Group Project and Seminar, a weekly seminar that will facilitate group meetings and coordinate milestone completions, as well as provide a forum for discussion regarding professional issues and system level design. Students will also be required to reflect on their teamwork experiences, their own learning, and their completed group project, and present their project in a public forum. Learning objectives for the Third Year Group Project and Seminar include a maturing of design thinking and creative thinking skills, consideration of qualities such as environmental and societal impacts of their design, deepening of system-level thinking, project management experience, teamwork and communication skills development.

ENGR 311 System Dynamics
Required of CE, EE, and ME students
Prerequisites: Multivariable Calculus & Linear Algebra, Circuits & Electronics, Applied Programming for Engineers
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week lab: 2
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 10 per week)

Students will apply a broad range of mathematical tools to systems represented by linear, lumped-parameter models. Many physical domains are considered, including translating and/or rotating mechanical, electrical, thermal and fluid systems. Planar motion of rigid bodies will also be studied. Analysis techniques include both transfer function and state-space representations. Time and frequency domain analyses are included, along with a brief introduction to Control Theory. This course includes a laboratory.

Topics: Development of system equations in many engineering domains (mechanical, electrical and electromechanical systems, fluid and thermal systems); applications of linear algebra, Laplace transforms, and Fourier analysis methods to problems in many engineering domains; transient and frequency domain response of systems; transfer functions and state space representation of systems; importance of poles and zeroes of a system; vibrating systems. Time-domain and frequency-domain analyses of dynamic systems, time-domain analyses of control systems, frequency-domain analyses and the design of control systems.

Lab Exercises: MATLAB; measurement of physical systems, modeling and simulation of linear systems; accelerometer, thermal, and oscilloscope measurement and modeling.

ENGR 312 Control Systems
Required of CE, EE, and ME students
Prerequisite: System Dynamics
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week lab: 2
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 10 per week)

Students will model dynamic mechanical systems in planar motion and use computer simulations to study them. Students build on the modeling and analysis techniques from System Dynamics to analyze and design controllers for linear systems. Practical examples from different engineering fields will be discussed. Students will analyze and design control systems in both continuous and discrete time, using both classical and modern techniques. Non-linear dynamic models are introduced.

Topics: Continuous and discrete time control; classical control – stability and design of systems using root locus and; modern control – state space and pole placement methods; models of physical systems (in the frequency and time domains), state-variable models, system responses (time response), control system characteristics, stability analysis (including Routh-Hurwitz criterion), steady-state errors. Root-Locus analysis and design, Nyquist/Bode methods, frequency-response analysis, frequency-response design, modern control design, discrete-time systems, also design via state space., sampled-data systems, analysis and design of digital control systems, discrete-time pole-assignment and state estimation, nonlinear system analysis, electro-mechanical actuators, and sensors.

Lab Exercises: Simulation, measurement and design of dynamic systems using LabView and/or MATLAB/Simulink, analytical instrumentation, industrial process techniques and instrumentation, process control methods, calibration, detection sensors, programmable controllers.

ENGR 400 Senior Project 1 ***(students do not officially register for this, however seminars are organized in Semester 1)***
Required of CE, EE, and ME students
Prerequisite: Third Year Project and concurrent enrollment in Project Management and Professional Practice
Credit Hours: 4; Hours per week classroom: 1 (meeting with advisor(s)); Hours per week lab: 4 (or more hours independent work)
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 14 per week)

In their final year, engineering students will undertake an individual or small group project (no more than 3 students) as a capstone experience to further their expertise in system level design, application, and the practice of the profession. These projects are supervised by faculty and sometimes by a professional from industry in addition to the faculty. The projects are designed to demand the application of skills the student has learned throughout the four years of the programme. Group projects are expected to cut across engineering disciplines and be more substantial in scope and effort than individual projects. One option for the senior project will be working with a corporate partner on a real-world engineering design and application project, called an *Ashesi-Corporate Project*. In these projects, students from different engineering majors and/or other disciplines (e.g. Computer Science, MIS, or Business) will work together on a project under the direction of both an Ashesi faculty member and a corporate partner, with funding provided by the corporate partner. Participation in Ashesi-Corporate Projects is competitive and is not guaranteed.

Senior Project 1 runs concurrently with Project Management and Professional Practice, which will serve to guide the project management timeline of the project. In addition, students will meet with their project supervisors regularly, and their project work will be assessed at the end of Senior Project 1.

Learning objectives include a maturation of design and system-level thinking, project management expertise, and a deep understanding of professional issues such as certification, professional boards and oversight, communication, ethics, and responsibility to employers, customers, society, and the environment.

ENGR 401 Senior Project and Seminar 2
Required of CE, EE, and ME students
Prerequisite: Senior Project 1
Credit Hours: 4; Hours per week classroom: 1.5 (seminar and meeting with advisor(s)); Hours per week lab: 4 (or more hours independent work)
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 14 per week)

This is a continuation of Senior Project 1. In Senior Project & Seminar 2, a one hour per week seminar provides a discussion forum for technical writing, ethics and social responsibility, and other topics, and will also serve to guide the project management timeline of the project. At the end of the senior project, students will write a summary of their work and do a public presentation of their work. To reinforce professional writing, each member of a senior group project will write-up their own supporting documents.

Learning objectives for the final year capstone project and seminar include a maturation of design and system-level thinking, project management expertise, and a deep understanding of professional issues such as certification, professional boards and oversight, communication, ethics, and responsibility to employers, customers, society, and the environment.

ENGR 413 Project Management and Professional Practice
Required of CE, EE, and ME students. BA/MIS students can enroll in this course as a Business Elective.
Prerequisite: Microeconomics or Principles of Economics, Leadership Seminar 4 for Engineers, and at least 6 Engineering courses
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

In this course students will learn to plan, strategize and execute an engineering project. The course will develop students' skills to manage projects and build on leadership skills and ethical reasoning they have acquired in core courses. Student will learn about environmental, safety and health issues that have to be considered during the implementation of a project. Students will also learn, discuss, and reflect on professional issues such as social responsibility, ethics, licensing, and regulatory reporting.

Topics: Project life cycle, feasibility study, planning, scheduling, cost estimation, resource allocation, budget management, monitoring and evaluation, logistics, management technology, managing project variables (including time management and quality management) professional, ethical, and health and safety issues. Introduction to Industrial Engineering (theory, practice, application), process management (labor, materials, overhead, risk management), work measurement, capacity utilization and constraints.

ENGR 414 Introduction to Environmental Science and Engineering
Elective for CE, EE, and ME students
Prerequisite: Concurrent enrollment in Thermodynamics
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week lab: 2
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 10 per week)

This course begins with a discussion of the local and global environment, environmental compartments and their relationship, pollution in these compartments, and basic descriptors. Systems analysis for environmental problems in areas such as water pollution, air pollution, solid and hazardous wastes, water and energy supply, and resource depletion are discussed, with an emphasis on the design of technological solutions. Students will work on projects in areas as varied as: renewable energy technologies, water quality, air quality, generators, increasing efficiency of appliances, urban planning, and cooking stoves.

Topics: Mass and energy transfer, environmental chemistry, mathematical modeling of growth, risk assessment, water pollution, water quality control, air pollution, global climate change, solid waste reduction, recycling, and management.

SC112 Physics I Mechanics
Required of CE, EE, and ME students Prerequisite: Calculus I (or Applied Calculus for non-Engineering majors)
Ashesi Unit Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week lab: 2
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 10 per week)

This course is an introduction to classical mechanics and fundamental physics theories. The course will focus on motion of objects using basic kinematic and kinetic principles. At the end of the course, students will have a firm understanding and practical experience with the fundamental mechanics theories. Some topics introduced in this course will be expanded in other advanced courses, such as Introduction to Thermal and Fluid Dynamics, Thermodynamics, Heat and Thermal system and Dynamic Systems. Writing quality lab reports will also be emphasized.

SC113 Physics II Electromagnetism
Required of CE, EE, and ME students
Prerequisite: Physics I Mechanics
Ashesi Units: 1; Credit hours: 4; Hours per week classroom: 3; Hours per week lab: 2
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 10 per week)

This course is an introduction to electrostatics, electrodynamics and electromagnetism. The basic principles behind electrical engineering and electronic communication will be discussed. At the end of the course students will understand simple electronic circuits and the fundamental theories and principles needed to continue their study of electronics and electrical systems. Writing quality lab reports will continue to be emphasized.

Computer Engineering Courses

CE 122 Applied Programming for Engineers
Required of CE, EE, and ME students
Prerequisite: Calculus 2 and Computer Programming (for Engineering or Computer Science)

Ashesi Units: 0.5; Credit Hours: 2; Hours per week classroom: 1.5
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 3 per week)

This course will build on students' existing computer programming experience and teach students how to use computers to solve engineering problems. Students will use the modeling skills they have gained from their mathematics courses and apply it to develop engineering simulations. Students will gain experience in writing applications in languages commonly found in engineering, such as C or Python. Students will also learn how real numbers are represented by computers, especially insofar as they affect precision and accuracy of calculations.

Topics: Programming in C and/or Python, simulation and the modeling process; errors, modeling errors, implementation errors, absolute and relative errors, error propagation; issues of numeric representation, calculation, and precision; modeling problems involving rate of change, under constrained growth and decay, constrained growth; modeling problems involving force and motion; data-driven models, monte-carlo simulations.

Lab Exercises: Scientific programming and simulations. Modeling specific problems such as falling motion, pendulum motion, gas motion and disease spread.

CE 322 Digital Systems Design
Required of CE, EE, and ME students
Prerequisite: Circuits and Electronics
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion/lab: 1.5
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 9 per week)

In this course students will study the principles of digital systems and computers. They will learn digital system theory and design techniques, including Boolean algebra, binary arithmetic, digital representation of data, truth tables, gates, flip-flops, finite state machines, memory, and timing issues. Students will gain experience with several levels of digital systems, from simple logic circuits to microcontrollers, in order to design, simulate and implement digital systems. They will also learn how processors and microcontrollers are used for control by interfacing sensors and actuators.

Topics: Binary numbers and operations, Boolean algebra, combinational and sequential logic, digital system design, finite state machines, hardware description language (such Verilog or VHDL), programmable devices, ADC and DAC, interface protocols, processor and microcontroller architecture and interface.

Lab Exercises: CAD tool and FPGAs, Introduction to HDL (Verilog or VHDL), combinational circuits (adder, encoder and decoders, multiplexer), sequential digital modules: (registers, timer), data acquisition, microcontroller, etc.

CE 451 Embedded Systems
Required of CE and EE students, elective for ME students
Prerequisite: Computer Programming (for Engineering or Computer Science) and Digital Systems Design (or Computer Organization for non-Engineering students)
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion/lab: 1.5
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 9 per week)

This course will cover the design and implementation of embedded systems from a hardware and software perspective. Students will go through the design process of embedded systems for specific applications and analyze the tradeoff between a hardware and software implementation. They will be introduced to fundamentals of digital system design using HDL (such as Verilog or VHDL), simulation, validation, synthesis and implementation. They will also learn software development techniques unique to embedded systems such as real time operations, I/O operations, and communications. They will have hands-on practical experience using programmable devices like FPGAs.

Topics: Processor interface, peripherals, external communication, bus systems, programmable devices, hardware/software optimization, embedded system OS (like Xlinix kernel, tinyos, linux), real time operation.

Lab exercises: Processor architecture (Microblaze MIPS processor), implementation of digital systems on FPGAs, design peripherals, peripheral – processor interface, embedded system development, memory and power optimization, simulation and validation, embedded system programming using C and other suitable languages.

Electrical and Electronic Engineering Courses

EE 222 Circuits and Electronics
Required of CE, EE, and ME students
Prerequisite: Physics II: Electromagnetism and *Multivariable Calculus & Linear Algebra*
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion/lab: 2
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 10 per week)

In this course students will study the principles and workings of electronic components and design circuits common in electronic systems like amplifiers and filters. Students will learn how to develop mathematical models for electronic circuits and find solutions in time and frequency domain. At the end of the course students should have learnt how to model and design simple analog electronics systems.

Topics: Electronic components (resistors, capacitors, inductors, diodes, transistors, relays, switches and transformers), solid state components (diodes, transistors, zener, photo diode, FET, MOSFET), circuit analysis, Kirchhoff's Laws, Norton's Theorem, Thevenin's Theorem, electronics networks, analog electronic circuits like amplifiers and filters, power sources, time domain and frequency domain solutions

Lab Exercises: Characteristics of electronic components like diode, pn junction, transistor, analysis and simulation of analog circuits, design of amplifiers, filters, rectifiers, oscillators, etc.

EE 242 Introduction to Electrical Machines and Power Electronics
Required of EE and ME students, elective for CE students
Prerequisite: Physics I: Mechanics, Physics II: Electromagnetism, and previous or concurrent enrollment in Circuits & Electronics
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 1.5; Hours per week discussion/lab: 2
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 7 per week)

This is a hands-on course that introduces students to the fundamental principles underlying electro-mechanical machines and devices, their design, and their maintenance. It provides a treatment of transformers, synchronous generators and motors, induction motors, DC motors, speed and torque control, protective devices, an introduction to power electronics, electrical (regenerative) braking.

Topics: Introduction to machinery principles; Transformers: (types and construction, Ideal transformer, single phase, tap changing, efficiency, equivalent circuit, autotransformer, three phase using two phase transformers, instrument transformers); Introduction to Power Electronics: components (diode, thyristor, DIAC, TRIAC), rectifier circuits; AC Machinery Fundamentals: rotating magnetic field, mmf and flux distribution, induced voltage and torque (2-pole stator, 3-phase coils), winding insulation, power flows and losses, voltage and speed regulation, Synchronous Generators: construction, speed, equivalent circuit, phasor diagrams, power and torque; Synchronous Motors: equivalent circuits, steady state operation (characteristic curves for torque, speed, load, power factor correction, synchronous capacitor etc.); Induction Motors: construction, torque, slip, frequency on rotor, equivalent circuits (transformer model, rotor model etc.), power and torque, motor-torque speed characteristics, starting circuits, speed control (pole changing, frequency, voltage, rotor resistance), induction motor drives; DC Machinery Fundamentals: commutation, construction, problems with commutation, power flow and losses, internal generated voltage and induced torque; DC Motors: separately excited and shunt DC motors, permanent magnet DC motor, series and compound DC motor (torque, speed characteristics and speed control), overview of DC starters.

Lab Exercises: Starting arrangements, coupling, motor performance under changing load and voltage, speed and torque control.

EE 321 Communication Systems

Required of CE and EE students, elective for ME students
Prerequisite: Physics II: Electromagnetism, Circuits and Electronics
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion/lab: 1.5
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 9 per week)

Students will learn the working principle and design of modern wired and wireless electronic communication systems. The course focuses on basic principles in the analysis and design of modern communication systems, the workhorses behind the information age. The treatment of analogue communications serves as a necessary background for understanding digital communications. At the end of the course, the students will have an introduction to electronic communication systems and their building blocks.

Topics: Deterministic and random signals and signal space, analysis and transmission of signals, transmission media and devices, analog and digital modulation systems (including amplitude modulation and demodulation, angle modulation and demodulation), sampling and analog to digital conversion, principles of digital data transmission, transmission over dispersive channels, fundamentals of probability theory, random processes and spectral analysis, performance analysis of modulated communication systems under noise, performance analysis of digital communication systems, spread spectrum communications, digital communications under linearly distortive channels, channel models, information theory, source and channel coding, error correcting codes.

Lab Exercises: Modulation, spectrum analysis, encoders and decoders, error detection and correction, signal strength.

EE 342 Electrical Machines II

Required of EE and elective for ME students
Prerequisite: Introduction to Electrical Machines and Power Electronics
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 1.5; Hours per week discussion/lab: 3
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 9 per week)

This is an advanced class that provides students further principles governing the operation of electro-mechanical machines and devices, their design, and their maintenance. There is also a treatment of special purpose motors such as variable reluctance machines and stepping motors. It provides an advanced treatment of power electronics, synchronous generators and motors including transients, induction motors (with topics including determining circuit model parameters etc.), induction generators, DC generators, parallel generators, transformers, single-phase and two-phase motors, speed and torque control.

Topics: Power Electronics: components (diode, thyristor, DIAC, TRIAC, power and speed comparison), rectifier circuits, pulse circuits, voltage variation by AC phase control, DC-to-DC power control-choppers, inverters, harmonic problems; Synchronous Generators*:* measuring model parameters, parallel operation of AC generators, synchronous generator transients, generator ratings (voltage, speed, frequency, power factor ratings, capability curves, short time operation and service factor);Synchronous Motors: characteristic curves, motor starting (with reduced frequency, external prime mover, amortisseur windings etc.), synchronous generators, motor ratings; Induction Motors: construction, torque, slip, frequency on rotor, equivalent circuits, characteristic curves, induction motor drives, determining circuit model parameters, induction generator, motor ratings; DC Motors and Generators: equivalent circuit, magnetization curve of DC machine, review motor types, and characteristics, DC starters, solid state speed controllers, efficiency, DC generators, (separately excited, shunt, series, cumulatively compounded and differentially compounded DC generator); Single-Phase and Special-Purpose Motors: single phase induction motors, cross field theory of single phase induction motors, starting arrangements (split phase, capacitor-start, permanent split, capacitor start-capacitor-run, shade pole,) speed control, equivalent circuit, Reluctance motors, hysteresis motor, stepper motors, brushless DC motors.

Lab Exercises: Thyristors, AC and DC motor control, servo motors, variable speed drives (AC and DC drives).

EE 421 Digital and Analog Signal Processing in Telecommunications
Elective for CE and EE students
Prerequisite: Communication Systems
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion/lab: 1.5
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 9 per week)

This course includes the study of signal processing and technology used in the telecommunication industry. Students will study various digital and analog signal processing techniques. Starting from the basic definitions of a discrete-time signal, through Fourier analysis, filter design, sampling, interpolation and quantization, more advanced tools are studied to aid the study and design of digital communications systems. Note: CE and EE students wishing to work in the telecommunications industry are advised to take *Digital and Analog Signal Processing in Telecommunications* as one of their electives.

Topics: Discrete time signals and systems; transform analysis of linear time invariant systems, z-transforms, sampling of continuous-time signals, structures for discrete-time systems, Fourier transforms, fast Fourier transforms, computation of the discrete Fourier transform, Fourier analysis of signals using the discrete Fourier transform, signal averaging, signal compression, convolution, parametric signal modeling, discrete Hilbert transforms filters, complex techniques, and applications of all of these.

Lab Exercise: Signal processing, spectrum analysis.

Mechanical Engineering Courses

ME 301 Mechanical Machine Design
Required of ME students, elective for EE students

Prerequisite: Physics I: Mechanics, Mechanics of Materials
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 1.5; Hours per week discussion/lab: 3
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 9 per week)

This class will introduce students to the common components of machine design.

***Topics*:** Principles of Machine Design; Materials; Stress and Deformation Analysis, Combined Stresses and Mohr's Circle, Design for Different Types of Loading; Fabrication Methods; Safety and Tolerance in Design and Fits; Design for Maintainability. Machine Frames, Design of Bolted Joints, Welded Joints, Screws, Springs, Hub-Shift Joints, Shafts and Shafting, Axles, Rolling Contact Bearings, Plain Surface Bearings, Gears and Gearing (including spur, helical, bevel gears and Wormgearing), Coupling Systems and Torque Converters, Keys and Seals; Transmission Systems, Linear Motion Elements, Lubrication, Belt Drives and Chain Drives, Kinematics of Gears; Applications of Machine Parts, Design of Power Transmission; Electric Motors and Controls, Motions Control (clutches and brakes).

Labs: Design projects involving CAD and fabrication of machine assemblies and components.

ME 311 Mechanics of Materials
Required of ME students, elective for EE students
Prerequisite: Physics I: Mechanics, Materials Science & Chemistry, and Dynamic Systems
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion/lab: 2
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 10 per week)

This course is the study of static mechanics of deformable bodies and introduces the design of engineering structures. Students will study the concept of stress and strain at a point, stress-temperature relationships, force and deformation analyses of bodies under axial, shearing, flexural, torsional and combined loadings, shear and bending moment diagrams, and Euler Columns. This course focuses on the application of static mechanics on engineering materials and structures. Students will learn how to model and simulate structures with distributed loads, thermal loads and torsional loads using software, scaled models and others for analysis and testing. At the end of the course students will be able to analyze integrity and stress of common engineering structures.

Topics: Equilibrium, stress, strain, deformation, elasticity, thermal stress, shear stress, stress concentration, elastic buckling of columns, bending of beams, concrete mixtures and structures, foundations. Energy methods of solving statically indeterminate situations.

Lab Exercise: Tension and compression, modulus of elasticity, measurement of torsion in shafts, coefficient of thermal expansion, modeling and simulation of structures.

ME 411 Thermodynamics
Required of EE and ME students, elective for CE students
Prerequisite: Physics I: Mechanics, Dynamic Systems
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion/lab: 1.5
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 9 per week)

This is an integrated course of thermodynamics and fluid dynamics theories and their application to engineering systems, and the study of heat transfer by conduction, convection, and radiation. The course will look at the application of thermodynamics and fluid dynamics principles in systems like engines,

refrigeration cycles and pumps. Students will study in detail the basic sciences behind thermal and fluid systems.

Topics: Ideal gas, thermodynamics laws, thermodynamic states or entropy and reversible and irreversible processes, thermodynamic equilibrium and entropy, heat transfer, volume, mass and energy conservation, Carnot, Rankine, Brayton, and Otto cycles, classification of fluid flow, ideal fluid flow, laminar and turbulent flow, flow analysis, head loss in pipes, mixtures, combustions, design of heat exchangers, NTU method.

Lab Exercises: Simulation of thermodynamics systems and fluid dynamics systems. Gas laws, spark-ignition cycle experiments, heat transfer, and refrigeration cycles.

ME 421 Heat Transfer
Required of ME students, elective for EE students
Prerequisite: Thermodynamics
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion/lab: 2
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 10 per week)

This course teaches students about design and analysis of thermal systems. Students will study the operation of different kinds of thermal engines, heating and cooling systems. They will apply thermodynamic and heat transfer principles to study thermal systems in different applications including power generation.

Topics: Rotodynamic machines (steam and gas turbine plants), positive displacement machines (compressors, pumps, air motors), reciprocating internal combustion engines, refrigeration, air-conditioning, psychrometry, and heat pumps. Heat transfer. Sources, use and management of energy.

ME 431 Fluid Mechanics and Applications
Elective for EE, ME students
Prerequisite: Thermodynamics
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion/lab: 1.5
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 9 per week)

This course is the application of fluid mechanics in engineering and industrial processes. The course will discuss theories and principles of fluid dynamics and statics using engineering applications as examples. They will learn how to design and analyze fluid systems like hydraulics, pneumatics, pipes, and pump systems. At the end of the course students should be able to design and analyze different fluid systems.

Topics: Hydrostatic pressure, buoyancy, the Bernoulli equation. Reynolds numbers, and predicting laminar or turbulent flow. Head loss computations. Velocity profiles in laminar and turbulent flow. Pump selection based on the pipe network being supplied. Fans, blowers, and compressors selection.

Lab Exercise: Viscosity measurement, designing hydraulic systems, analysis and design of duct and pipe systems, simulation of fluid mechanics systems.

ME 441 Manufacturing Processes
Required for ME, Elective for CE, ME students
Prerequisite: none
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion/lab: 2
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 10 per week)

Manufacturing industries are a vital component of all modern economies and all of them require employees who are skilled in, and knowledgeable about, manufacturing processes. This course is designed to provide students with an overview of a wide variety of manufacturing processes. It deals with the principles, analysis and selection of manufacturing processes. Students will understand solidification, metal forming and sheet metalworking, material removal, joining, and assembly processes. Manufacturing systems will be discussed. Design for manufacturing and manufacturing economics are introduced. Lab sections and an individual final project will provide students valuable hands-on experience in using machines to design and make products.

EE 451 Power Engineering
Elective for EE, ME students
Prerequisite: Circuits and Electronics, Introduction to Electrical Machines and Power Electronics
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion/lab: 1.5
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 9 per week)

This course is the study of electrical energy generation and use in various industries. The course will look at how electrical energy is generated from and converted to other forms of energy. Students will study power generation systems, transmission, distribution systems, electrical components, electric power utilization and power quality. Students will also study how to strategically bring together power technology to make needed energy available by considering need, the environment, and sustainability. Note: EE and ME majors wishing to work in the power systems industry are advised to take *Power Engineering* and *Power Systems Analysis* as their two electives.

Topics: Power generation technologies, power transformers, motors, power distribution analysis and design, power network monitoring and control, uninterrupted power supplies, hydro, thermal, and renewable power sources (e.g. solar, wind), high voltage components including transmission line structures, grid, operation, power stations and generating plants, protection, insulation, reactive power compensation, high voltage DC transmission, control systems and power system operation, distribution short circuit protection, electric power utilization (metering, load characteristics), power quality (e.g. harmonics, voltage fluctuations), and a review of synchronous electrical machinery and thermal generating plants.

Lab exercises: Power generators, transformer synchronization, conductance measurements, test and measurement of power systems, power system design. Group Project: network design, power system for industry, alternative power source, wind turbine, analyze solar power, etc.

EE 453 Power Systems Analysis
Elective for EE and ME students
Prerequisite: Power Engineering
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion/lab: 1.5
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 9 per week)

This course is a study of advanced topics in electric power distribution systems planning and operation. In this course, students will learn how to analyze flows on power networks and their applications to real systems. It provides students with a working knowledge of power system problems and computer techniques used to solve some of these problems. It also provides a technical treatment of the general problem of power system stability and its relevance. They will learn how to strategically bring together power technology to make energy available to industry by considering need, environment and sustainability. Note: EE and ME majors wishing to work in the power systems industry are advised to take *Power Engineering* and *Power Systems Analysis* as their two electives.

Topics: Network equations, and per unit system, power transformers, transmission line parameters and modeling (including induction and complex power transmission), steady state and transient operation, transformer modeling, generator modeling (machine view point and circuit viewpoint), network matrices, power flow analysis (including solution by Newton-Raphson and Gauss iteration), faults (symmetrical and unsymmetrical), system protection, power system controls, transient stability, power distribution. Economic operation of power systems.

Lab Exercise: Transmission Line Modeling, transmission line with different load conditions, load flow analysis etc.

EE 422 Advanced Communication Systems
Elective for EE and ME students
Prerequisite:
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion/lab: 1.5
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 9 per week)

The course will describe the protocols used in current networks. It will provide skills needed in designing and deploying efficient and effective data communications and network technologies. Key Topics include: Wireless and Mobile Communication (Cellular concept, propagation methods/models, antennae, Coding and multi access techniques, Higher Order Modulation – OFDM, etc.) Mobile generations and technology, Digital TV Broadcasting, Core network), Telecommunication Networks (PSTN, IP Radio Access Networks), Advanced Topics in IP Networks (Mobile IP, Quality of Service, Multimedia networking protocols), Switching, Wireless LAN and Mobile Ad-hoc Networks, Fiber Optic Communication and Network, Satellite communications.

This course will also develop understanding of some fundamental concepts of information theory, as well as techniques used to model and analyze communication networks. It will briefly highlight how to develop analytical tools and conceptual models for modeling and analyzing network performance. Subtopics will include: Fairness and network utility maximization, Optimization based routing and congestion control, Basic queueing models and their application to switching and scheduling in networks.

EE454: Renewable Energy and Smart Power Grid
Elective for EE and ME students
Prerequisite: Power System Engineering and Power Electronics
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion/lab: 1.5
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 9 per week)

A Smart Grid is the integration of numerous technologies, systems and processes with the aim to modernize and fully automate the entire electricity grid covering generation, transmission, distribution, utilization plus conservation of energy. This course introduces students to smart grids and intelligent distribution networks. Renewable energy sources and their integration in smart grids as well as energy storage technologies are discussed and these include distributed generation technologies, control technologies, modeling and storage technologies. Demand side/load management is explored, including reactive power optimization. Other topics that this course addresses are smart metering techniques, grid network security and best practices in this domain. Students will also be introduced to electric vehicles in smart grids.

Key topics include: Information and communication technologies for smart grid, Communication technologies for the smart grid, information security, Sensing, measurement, control and automation

technologies: smart metering and demand-side integration, distribution automation equipment, distribution management systems, transmission system operation. Power electronics and energy storage: power electronic converters, power electronics in the smart grid, and for bulk power flows.

ENGR 442: Mechatronics Systems Design
Elective for EE and ME students
Prerequisite: Mechanics, Sensors, Control theory, Microcontrollers, Electronics, and Electrical Motors.
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion/lab: 1.5
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 9 per week)

Mechatronics is the synergistic integration of mechanical disciplines, controls, electronics and computers (software) in the design of high-performance machines, devices and processes. This course reviews principles in software programming, machine design, modelling of multi-domain dynamic systems, controls theory, electronics circuits, real-time controls implementation, and system-level integration. Hands-on lab exercises and projects provide extensive coverage of mechanical components, sensors, actuators, electrical drives, signal conditioning circuits, modelling and simulation tools, DAQ hardware and software (microcontrollers), and microprocessors. The main idea of the course is to review and interface the described subsystems to design fully integrated mechatronic systems that meet specified requirements.

EE442 Power Electronics
Elective for EE and ME seniors and juniors students
Prerequisite:
Credit Hours:TBD

Hours of Study outside of the class (reading, assignments, studying, projects, and so on: TBD per week)

In Power Electronics students will study various static methods to control the power flow between source and load. Due to the high level of power, the main solution for these methods is either forced switching for transistors or naturally for diodes; the thyristors present a forced switching ON and naturally switching OFF.

This subject aims at familiarizing the student with power electronic components in terms of *how they work* and *how they are applied*. First of all, the student must learn to know the operation and limitations of the different components. Secondly this course aims at creating an understanding of how these components are applied in different basic types of converters like ac-to-dc converters (rectifiers), dc-ac converters (inverters), dc-dc converters (choppers & switch-mode power supplies) and other types of power conversion methods. A basic foundation is also laid concerning the parameters with which the performance of these converters is measured.

Power Electronic converters like ac and dc drives are used more and more to control the speed and torque of ac and dc motors which are covered in subjects like Electrical Machines. The controlling of these motors by drives is used in factory processes. Electric drives are also introduced in this course.

Topics include Power Electronics Devices, Applications, Limitation of semiconductor devices and methods to prevent their failure, AC-to- DC Power Conversion, DC-to- DC Power Conversion (Choppers); DC-to- AC Power Conversion (Inverters), Control of Power Conversion in Power Electronics.

ENGR 443 Industrial Engineering
Elective for
Prerequisite: Students should have completed Algebra, Statistics and Engineering Design.
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion/lab: 1.5
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 9 per week)

A central idea behind this course, as well as in the whole engineering education programme, is that the student should be trained in solving engineering problems for organisational development in technology-based companies and organisations. The major aim of the course is to give a general orientation about and a perspective on the subject of Industrial Engineering and maintenance operations, as well as to create interest in and understanding of the continued studies in the subject area. The course thus prepares the student for a professional career as an engineer of Industrial Engineering and Management and for further studies. This course will familiarize students with principles of methods engineering, forecasting techniques, layouts and material handling, human factors and ergonomics, quality management and inventory control, and maintenance operations. We will discuss maintenance procedures and practices for mostly encountered components and machines in the production industry.

CAD/CAM
Elective for
Prerequisite:
Credit Hours: TBD
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: TBD per week)

This course integrates computer-aided design (CAD) and computer-aided manufacturing (CAM) in modern manufacturing processes. It exposes students to CAD and CAM tools for use in engineering design conceptualization. The course involves introduction to CAD/CAM, advanced CAD modeling techniques, computer numerical control (CNC) machines, 3D printers, machine coded programmed instructions (G and M Codes), machine tooling, and introduction to finite element analysis (FEA), including topology optimization. Electrical engineering drawing will be introduced. Students will be exposed to various CAD, FEA, and CAM software. A project will be assigned that will involve design, analysis, evaluation and optimization, and a CAM system to generate and assemble a simple mechanical or electrical or electro-mechanical device.

Topics: Introduction to CAD, CAM, and CAE (Computer Aided Engineering), Machine Coded Programmed Instructions (G and M Codes), Computer Numerical Control (CNC) Machines, 3D Printers, and Machine Tooling. CAD: Geometric Modeling (2D and 3D Modeling, Parametric Modeling, Design of Molds, Sheet Metal Parts, Weldments, Surface Modeling, etc.) and Advanced Assembly Operations. FEA (Structural Analysis, including Topology Optimization). Electrical Engineering Drawing. Analysis of Mechanisms.

Industrial Automation
Prerequisite: Digital Systems Design or Electrical Machines
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion/lab: 1.5
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 9 per week)

This course is a practical introduction to industrial automation systems, with applications to the process industry and discrete manufacturing. The course gives students both a hands-on introduction to this field and the theoretical underpinnings governing the design and workings of various components in an automation system. Topics include an overview of industrial automation and process control, automation circuits, components including actuators, sensors, timers, encoders, etc. The design, synthesis and implementation of automation circuits. State diagram realization, electro-pneumatic components, PLC technology and special purpose I/O modules, PLC programing. Industrial networks, SCADA systems Labs will include PLC programing, use of a range of common sensors, actuators, transmitters, use of electric drives, pneumatic components. Emphasis on common industrial applications.

Special Non-Major Electives

Analog signal processing and Computer Aid Design
Elective for
Prerequisite:
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion/lab: 1.5
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 9 per week)

The goal of this lecturer is to help students to understand the principles of signal processing. Learn how to simulate and evaluate the main features using real examples of schematics.

1. Examples of sensors generating an electrical signal.

2. Why this signal needs to be processed. Introduction to noise issues.

3. Practical operational amplifiers: generalities, limitations and stability.

4. Read out chain using operational amplifiers (amplification, filtering, peak detectors, comparators, peak detectors, multiplexing).

5. Introduction to switched-capacitor circuits.

6. Drivers and reference voltage.

7. Analog to digital converters: concept and basic architectures.

8. Digital data transmission.

Computer Science Courses

In today's society, every University graduate must be able to utilize computers as a tool in their professional work; this is especially true of engineers, whose technical work relies on computers for design, simulation, and modeling. In addition, computerized components are integrated into a myriad of engineered projects, and so all engineers should have grounding in basic programming and computer systems.

Computer Science core or elective courses for the Engineering Program are:

CS 112 Computer Programming for Engineering
Required of CE, EE, and ME majors, an option for CS and MIS majors as of Fall 2015
Prerequisite: Familiarity with computers
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week lab: 1.5
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 9 per week)

This is a first course in computer programming, primarily intended for students pursuing a major in computer science or engineering, and/or who have had some previous programming practice. Topics include computer representation of data, object-oriented programming, variables and assignments, primitive types and operations, conditional execution, iteration, arrays, classes, methods, recursion, object types, encapsulation, inheritance and reasoning about programs. The course includes a laboratory component designed to enhance conceptualization.

CS 222 Data Structures and Algorithms
Required of CE and CS majors, elective for EE, ME, and MIS majors
Prerequisite: Computer Programming (for Engineering or Computer Science)
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week lab: 1.5
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 9 per week)

This course covers fundamental abstract data types and their implementations as data structures such as lists and trees and introduces asymptotic analyses of algorithms involving these data structures. Students will also learn about searching (dictionaries, priority queues, and hashing); sorting (internal and external); graphs and algorithms on graphs (shortest path, minimum spanning trees); and pattern matching.

CS 312 Intermediate Computer Programming
Elective for CE, EE, ME and MIS majors, required for CS majors
Prerequisite: Computer Programming (for Engineering or Computer Science)
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week lab: 1.5
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 9 per week)

This course will introduce students to more details of object definition, program construction, and event-driven programming. It will also introduce additional standard Java packages, including the file system and graphical user interface elements. Basic data structures will be introduced and implemented, including lists, stacks, queues, and simple kinds of trees (through binary search trees). This course will also give students an introduction to C++ and to programming techniques for dynamic data structures. Students will study algorithms for ordering, searching, traversing and manipulating these data structures, including some recursive algorithms. Good software engineering practices will be featured in various aspects of the course, and notations similar to the Unified Modeling Language (UML) will be employed. Through one or

more team projects, students will gain experience in designing and implementing larger systems. However, the emphasis of the course will be on the use of prewritten packages and built-in language facilities, as well as design and implementation of moderately sized custom classes and algorithms, rather than on the design of whole systems.

CS 323 Database Management
Elective for CE majors, required for CS and MIS majors
Prerequisite: Computer Programming (for Engineering or Computer Science) and Digital Systems Design (or Discrete Mathematics or Data Structures & Algorithms)
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week lab: 1.5
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 9 per week)

This course provides a comprehensive overview of database systems. Students will learn the fundamentals of data access and file systems, including hierarchical, network, relational and object-oriented data models. The course will cover the elements of relational database design, data query languages, services such as data protection and integrity control, and database management. The course will provide a balance of theory and practical application and will culminate in a database implementation project conducted by teams of students.

CS 415 Software Engineering
Elective for CE and EE majors; required of CS and MIS majors
Prerequisite: Computer Programming and 3rd Year Group Project
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week lab: 1.5
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 9 per week)

This course covers the fundamentals of software engineering with a focus on the software lifecycle and developing quality software as a team. Topics covered include requirements, specification, design, quality assurance and testing, process, as well as tools and environments. The course will include a programming project in which teams of 4-6 students take a high-level concept provided by the instructor from requirements through implementation.

CS 432 Networks and Distributed Computing
Required of CE, CS, and MIS majors, elective for EE and ME majors
Prerequisite: Computer Programming
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week lab: 1.5
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 9 per week)

This course introduces the underlying principles of computer network design, from the physical layer up through data transport protocols. Physical layer interface alternatives and mechanisms employed by common protocols at layers 2 to 4 are discussed. Methods for constructing distributed computing systems and network services are discussed in the context of common internet systems such as electronic mail, print and file servers and Web services. A holistic view of network and information security is introduced: encryption standards, cryptographic techniques and social issues. The goal of this course is to provide students with an understanding of how to construct large-scale computer networks. Note: EE majors

wishing to work in the telecommunications industry are advised to take *Networks and Distributed Computing and Digital and Analog Signal Processing in Telecommunications* as their two electives.

Topics: Applications of networks, hardware and software, network architecture reference models, physical layer interface alternatives: guided and unguided media, and common networks including fiber, VSAT, cable standards, wireless standards and networks such as mobile telephone systems. Modulation and multiplexing techniques. An introduction to information theory (Shannon, Nyquist etc.). Protocols for flow control, error detection and control, media access control, routing and congestion control, and transport protocols. Sockets programming is introduced. Cryptography, authentication, public key algorithms, symmetric key algorithms and digital signatures.

CS 435 Operating Systems
Required of CE, CS, and MIS majors; elective for EE majors
Prerequisite: Computer Programming and Digital Systems Design
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week lab: 1.5
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 9 per week)

The course covers the main concepts and issues in operating system design, implementation and engineering, and is roughly divided along three dimensions: core operating systems concepts, information technology, and systems programming. Core operating system concepts involves understanding how operating systems work, what the features are, how they are designed, the issues with various approaches, and an overview of computer science techniques used or applied in operating systems. The aim of this part of the course is for students to understand and even build or contribute to some parts of an operating system. The course will include a team project.

Topics: Operating system structures, processes, threads, CPU scheduling, synchronization and deadlocks, system calls, interrupts, OS data structures, process management, memory management, including virtual memory, storage/file system management, mass storage structure, I/O systems, device management, resource allocation, scheduling, security and protection, Storage management: distributed System structures, distributed file systems and distributed coordination. Real time operating systems. Case study of influential operating systems (including at least one of Linux, Windows). Overview of system administration, OS installation and configuration, shell scripting, system programming, applications support, case studies.

CS 453 Robotics
Elective for CE, EE, ME, CS, and MIS majors
Prerequisite: Computer Programming and Calculus I
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week lab: 1.5
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 9 per week)

This course gives a practical hands-on as well as theoretical introduction to robotics as a field that integrates expertise in Computer Science, Engineering, Design and Mathematics to create innovative systems that interact with and can operate autonomously or semi-autonomously in the physical world. In this course, students will work individually and in groups to implement robotics projects using robotics platforms such as the Lego Mindstorms and EV3 kits, and the TurtleBot robot, as well as other electronic and mechanical components. Through these projects, they will learn how to build and write programs for an autonomous physical device that interacts with its environment. They will also learn to read and

understand robotics research papers, to give presentations to technical and non-technical audiences, and follow a project from an initial idea through design to implementation and testing.

Topics: Historical overview of robotics, mobile robots and manipulators, kinematics of differential drive robotics, basic kinematics of manipulators, locomotion, sensing and perception, vision, control, motion planning, task planning, control architectures, advanced/special topics such as multi-robot coordination, robot learning.

CS 458 Internet of Things

Elective for CE, EE, ME, CS, and MIS majors
Prerequisite: none
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week lab: 1.5
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 9 per week)

The Internet of Things (IoT) course takes an end-to-end view of IoT including the devices, networks, data analytics, programming, security, and business. It exposes the student to all aspects of a functional IoT system and how to design a secure, robust and scalable IoT network, taking on a hands-on approach.

Labs and small projects will be used to gain understanding of key concepts at the various layers. Key among these are the devices, network protocols, data and programming aspects. Students will review hardware types and software tools and be introduced to IoT design principles which cover how to transition from an IoT idea to an IoT product, building prototypes and commercializing them.

Since IoT is still emerging, businesses are going to be either adopting IoT solutions or transforming their existing businesses to include IoT in a seamless and sustainable manner. The course addresses these aspects as well, in order to prepare participants to lead in this budding industry in the business segment.

AS 111 Ashesi Success
Required for All Freshmen
Prerequisite(s): None
Offered: Spring
Course Type: Seminar, Experiential
Credit Hours: 3; Ashesi Unit Units: 0; Hours per week classroom: 3; Hours per week discussion: 0

A program designed to enhance your overall success in college and in life. The most important objective of the program is personal empowerment: learning who you are as a college student, learning who you are as a human being and what you stand for, learning how to speak up when your values are in conflict with those around you, and learning what it takes for you to keep yourself balanced and on course to success. When you are empowered, your actions are more purposeful and your choices more deliberate. When you are empowered, you are more engaged and more motivated every day. And when you are empowered, you have a greater sense of well-being and enjoyment in life.

ENGL 112 Written and Oral Communication
Required for all BA, MIS & CS, ENG Majors
Prerequisite(s): None
Offered: Spring
Course Type: Lecture
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

This course offers an introduction to the practices of reading and writing for general university studies. Students will develop academic writing and analytical skills through critical reading, group discussion and various writing assignments. Strong emphasis will be placed on revising, with weekly workshops to clarify assignments and expectations and/or receive recommendations and feedback on works in progress.

ENGL 113 Text and Meaning
Required for all MIS & CS, ENG Majors
Prerequisite(s): None
Offered: Spring
Course Type: Lecture
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

Text and Meaning takes a fresh approach to the study of literary and critical theory, integrating critical thinking into activities to increase students' very ability to learn and question. It is designed to teach students critical thinking skills, how to pose questions, propose hypotheses, gather and analyze data, and make arguments. To accomplish this, the term 'text' is used in its broadest possible sense, and includes literature, newspapers, magazines, speeches, advertising, websites, blogs, film, music and documentaries. Put simply, Text and Meaning encourages students to do their own intellectual fishing, instead of waiting to be served.

ENGL 215 African Literature
Non-major elective
Prerequisite(s): Written and Oral Communication
Offered: Typically offered in the Fall

Course Type: Lecture
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

African Literature, as a broad conceptual category, covers a broad array of discourses flung across the continent's various sub-cultures and its multiple language heritages. Given that wide and far-reaching background, we shall set ourselves a modest and researchable goal for the semester: we shall imagine the course as a survey course meant to offer a formal introduction to African literature in its broadest historical and cultural contexts. We shall interrogate some popular debates within African literary discourse (colonialism and cultural imperialism; the possibility of an "African" literature in non-African but Europhone languages; cultural nationalism and the independent nation-state; and gender, sexuality and African cultural traditions) and also invoke the peculiar historical, socio-cultural and cultural contexts that inform our selected texts.

ENGL 231 African Literature & Film (Women Writing Africa: Female Writers in Modern African Literatures and Films)
Can be taken as an Elective
Prerequisite(s): None
Offered: Typically offered in the Spring/Fall
Course Type: Lecture
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

This course is premised on a central question: How have African women's voices and images been shaped, heard, and/or represented in postcolonial Africa? The course seeks to enable students to understand ways in which contemporary African culture is being reconstructed through the restoration of women's voices in the public sphere by African women writers and film makers. Particular attention is paid to the feminine point of view in ways that challenge the representation of women and their experiences in male-authored literatures and films in postcolonial Anglophone and Francophone Africa. Students read and critique several works by African female writers, watch films and documentaries by both female and male writers/producers, and explore changes in concepts such as "woman," "wife," and "mother" from contemporary African perspectives under the general rubric of "African Feminism". But in this course we pay attention to Chinua Achebe's perspective on the role of literature/artist in postcolonial Africa. On the charge that the African literary artist was too earnest, too political, Achebe argued that for the African artist, "art for art's sake is just another deodorized dogshit" (1964; 1973:8). There will also be a serious analysis of indigenous African proverbs as they pertain to the female-male discourse.

In this course we approach feminism in modern African literatures in line with Alice Walker's coined word, "womanism". Walker delineates this discourse in terms of complimentary relationships between women and men. The concept also draws a distinction between Western "bourgeois" feminism which is primarily satisfied with political changes that for the most part affected only the elite and did not affect their class privilege. The course thus essentially lifts up Walker's line of thought evident in the writings of modern African women such as Chicwenye Ogunyemi. She has opined that, instead of denigrating (Black) manhood, womanism rather recognizes its collaborative potential, believes in him, and empowers him. Womanist writings would, therefore, almost always end in `integrative images of male and female worlds.' Participants in the course will be led to assess Ogunyemi's perspective that, "A Black woman writer is likely to be a `womanist'. That is, she will recognize that along with her consciousness of sexual issues, she must incorporate racial, cultural, national, economic and political considerations in her

philosophy" (1985:64). Discussion of gender relations in modern African women's writings is therefore understood as:

- A specific response to indigenous and colonial (Islamic and Western) patriarchies.
- An articulation of African women's concerns through a medium—modern African literatures—originally dominated by men.
- Located within the broader social and cultural contexts of African societies and shaped by political and economic interests.
- Discrimination that African women experience and their strategies for coping with it.

FRENC 111 Introductory French 1
Non-major elective
Prerequisite(s): None
Offered: Fall
Course Type: Lecture
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

The economic development being experienced by Ghana and the geographical location of the country (surrounded by francophone countries), its trade relations with its neighboring francophone countries, makes both the French language a fundamental means of communication in Ghana, especially in business and at all levels of business transactions**.** To be competent and competitive in the region, companies have understood that to be able to communicate, both in French and English is a plus, and that there is therefore a need to have bilingually trained staff.

In response to this need, Ashesi University has decided to offer its students, training in French, which will enable them to become « independent users » of French which means that they can easily survive in a francophone environment. The objective is to bring them to attain a level B1 or B2 of the CEFR (Common European Framework of Reference for Languages).

The Common European Framework divides learners into three broad divisions that can be divided into six levels: A1, A2, B1, B2, C1 & C2. For each level, it describes what a learner should be able to do in reading, listening, speaking and writing. **We want our students who are taking the Introduction to French 1 class to get to meet the requirements of level A1**.

FRENC 122 Professional French 1
Non-major elective
Prerequisite(s): None
Offered: Fall
Course Type: Lecture
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

The economic development being experienced by Ghana and the geographical location of the country (surrounded by francophone countries), its trade relations with its neighboring francophone countries, makes both the French language a fundamental means of communication in Ghana, especially in business and at all levels of business transactions**.** To be competent and competitive in the region, companies have

understood that to be able to communicate both in French and English is a plus, and that there is therefore a need to have bilingually trained staff.

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FRENC 123 Introductory French 2
Non-major elective
Prerequisite(s): None
Offered: Spring
Course Type: Lecture
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

The economic development being experienced by Ghana and the geographical location of the country (surrounded by francophone countries), its trade relations with its neighboring francophone countries, makes both the French language a fundamental means of communication in Ghana, especially in business and at all levels of business transactions**.** To be competent and competitive in the region, companies have understood that to be able to communicate, both in French and English is a plus, and that there is therefore a need to have bilingually trained staff.

In response to this need, Ashesi University has decided to offer its students, training in French, which will enable them to become « independent users » of French which means that they can easily survive in a francophone environment. The objective is to bring them to attain a level B1 or B2 of the CEFR (Common European Framework of Reference for Languages).

The Common European Framework divides learners into three broad divisions that can be divided into six levels: A1, A2, B1, B2, C1 & C2. For each level, it describes what a learner should be able to do in reading, listening, speaking, and writing. **We want our students who are taking the Intermediate French 2 class to go towards the requirements of level B1.**

FRENC 214 Professional French 2
Non-major elective
Prerequisite(s): None
Offered: Spring
Course Type: Lecture
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

The economic development being experienced by Ghana and the geographical location of the country (surrounded by francophone countries), its trade relations with its neighboring francophone countries, makes both the French language a fundamental means of communication in Ghana, especially in business and at all levels of business transactions**.** To be competent and competitive in the region, companies have

understood that to be able to communicate both in French and English is a plus, and that there is therefore a need to have bilingually trained staff.

In response to this need, Ashesi University has decided to offer its students, training in French, which will enable them to become « independent users » of French which means that they can easily survive in a francophone environment. The objective is to bring them to attain a level B1 or B2 of the CEFR (Common European Framework of Reference for Languages).

The Common European Framework divides learners into three broad divisions that can be divided into six levels: A1, A2, B1, B2, C1 & C2. For each level, it describes what a learner should be able to do in reading, listening, speaking and writing. **We want our students who are taking the Professional French 2 class to get to meet the requirements of level B1**.

POLS 221 African Philosophical Thought
Non-major elective
Prerequisite(s): Written and Oral Communication
Offered: Typically offered in the Fall
Course Type: Lecture
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

A serious thinking through or reflection on the practical/tangible aspects of the human experience is the goal of philosophy. This course is an introduction to a variety of themes of philosophical thinking in Africa. The approach adopted to advance the goals of the course, differs from traditional philosophy courses in a significant way. Specifically, we will read about the works of African philosophers; apply/interrogate such thoughts in such works to grounded cultural practices in actual and mediated lives; and think through and dialogue with fellow colleagues on the readings in this class. Thus, needless to say, throughout the course we will use concrete examples to ground readings which may sometimes be abstract. The goal of this grounded approach is to demonstrate the relevance of philosophical thinking in contemporary times and also to negate the idea that 'philosophy' does not 'touch ground' (that is, it is only intellectual exercise) and is thus only a 'thinking' (and boring) subject.

POLS 231 Africa in International Settings: Africa Beyond Aid
Non-major elective
Prerequisite(s): Written and Oral Communication
Offered: Fall & Spring
Course Type: Lecture
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

Across the African continent many want to do away with decades of aid dependency striving instead for a more assertive Africa on the international scene. This course encourages informed debate and a varied assessment of what overseas development assistance has evolved into over the years and how can it be complemented and replaced by more effective and relevant resources. It will offer a variety of case studies from individual African countries as well as identifying regional trends and characteristics.

The course aims to locate the topical 'Beyond Aid' debate in a theoretical, historical and regional perspective. It offers an introduction to main tenets of development theory and provides an overview of how international norms guiding development policy have evolved from the first development decade of the 1960s to the Sustainable Development Goals (SDGs) adopted by the UN in 2015.

Furthermore, the course assesses the changing role of development assistance in the context of African economic and social development and will compare contemporary data on the role of aid relative to trade, remittances and foreign direct investments. It will look at challenges confronting African countries aiming to offer a more diverse and varied understanding of development options and constraints relative to the often-stereotyped perceptions of 'one size fits all' presumably meant to apply across 54 very different nations on the continent. And it will look at how access to financial resources influence the position of African governments in shaping current geopolitical alliances.

POLS 332 Governance in Africa
Non-major elective
Prerequisite(s): Written and Oral Communication
Offered: Typically offered in the Spring
Course Type: Lecture
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

What are the big ideas, essential questions, disciplinary ways of thinking, and/or approaches to problem solving that students will engage with in the course? Why are they relevant?

In social theory as well as public policy the concept of 'governance' is often associated with normative prefixes: *good* governance, *effective* governance, *sound* governance etc. Likewise, governance may often be perceived as acts performed primarily by governments.

This course will aim to unpack governance from the 'embrace' of being a government prerogative and rather consider governance as institutional processes involving multiple actors inside and outside of government who endeavor to arrive at effective rules of the game for authoritative decision-making.

Rather than promoting a normative scheme, the course will suggest that governance must be considered as decisively shaped by the country and societal context. It offers a pragmatic approach to what can be considered 'best fit' given the circumstances rather than ideal notions of 'best practice'.

Such an approach offers analytical tools and enhanced awareness of how existing governance arrangements affect available opportunities and by what means institutional frameworks can be adjusted and made more responsive to needs of citizens, enterprises, and the wider society. The course offers a balance between global and international ideas and theories on governance on the one hand and on the other hand specific case studies from the African region, thereby aiming to verify and qualify generic statements on the nature of politics in Africa.

SOAN 220 Embodied African Aesthetics Foundations
Non-major elective
Prerequisite(s): Written and Oral Communication
Offered: Spring
Course Type: Lecture, Experiential
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

It entails various aspects of African culture including music, dance, language, religion, cosmology and symbolism. Usually, teaching this course in the summer makes use of both ontological and epistemological approaches with loads of photos, videos and practical demonstrations.

SOAN 225 Ghanaian Popular Culture
Non-major elective
Prerequisite(s): Written and Oral Communication
Offered: Typically offered in the Spring
Course Type: Lecture
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

This Ghanaian Popular Culture course is an undergraduate, 300-level, African Studies elective at Ashesi University. The course uses creative and engaging content in Ghanaian Popular Culture (for instance, video movies, vehicle inscriptions, political cartoons) as a channel for teaching disciplinary analytical thinking and reasoning skills to focus on academic writing, and to indirectly prepare students for capstone projects.

SOAN 233 African Music and the Contemporary Art Music Scene
Non-major elective
Prerequisite(s): None
Offered: Typically offered in the Spring
Course Type: Lecture, Experiential
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

This course explores the role of music and dance as essential components of life within African traditions. It introduces students to the basic elements of African life as connected to music and dance. It will extend to include some aspects of contemporary African music and dance. The course exposes students to the connection between music and dance and their role as repositories of African indigenous knowledge, values and virtues. Students will be given skills to conceptually and practically explore the socio-historical and cultural contexts of the African life through examination of specific music and dance types. It will be delivered through lectures, workshops, practical observations and demonstrations.

SOAN 227 Religion in Africa
Can be taken as an Elective
Prerequisite(s): None
Offered: Spring
Course Type: Lecture
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

This course is an introduction to a cross-cultural study of religions and cultures of Africa through the disciplines of anthropology, history, and sociology of religion. The goal of the course is to teach students to think critically about the traditional religious heritage of Africa as a profound reflection on the human condition. This goal is achieved through a systematic study of the attitudes of mind, beliefs, as well as practices which have evolved in the many African societies such as the Akan of Ghana, Yoruba and Ibo of Nigeria, Malinke of Guinea, the Ewe/Fon of Dahomey/Benin, the Luo of Tanzania, K(G)ikuyu and Masai of Kenya, the Zulu of Southern Africa, and the Mende of Sierra Leone. Through the viewing of documentary

films, movies, lectures, and discussions, the meaning, structure, nature, and world views of contemporary Africans are closely examined.

In addition, the course offers an overview of how cultural and religious knowledge is generated, understood, and used as Africans in general and Sub-Saharan Africans in particular, draw on their music and dance, myths, art forms and symbols to articulate and elaborate on the cosmos, life, sickness, health, and death, as they organize their lives. It does so by retrieving and analyzing the significance of creation myths, religious personalities such as rulers, diviners, and healers, in relation to the role of the ancestors.

Finally, it reflects on the social, cultural and historical factors which have engendered religious changes in Africa. Particularly it unpacks the problematic emergence of two world religions, Christianity and Islam—"Guest Religions"—and their encounters with the indigenous religions of Africa. Attention is paid to the impact is the "host" on the "guest" religions. In the end, it is hoped that students are enabled to interpret, articulate and synthesize religious knowledge, experience, and reflection as they deal with African ideas, belief systems and practices.

SOAN 301 Introduction to Africana Studies: The Global Black Experience
Can be taken as an Elective
Prerequisite(s): None
Offered: Fall & Spring
Course Type: Lecture
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

Introduction to Africana Studies surveys the sum-total of the content of Black peoples' lives historically and in the present. The course raises and attempts to answer some key questions: What is the nature and historical contours of the Global Black Experience? How have our understandings and appreciations of this experience changed over time? What is "Africa" to (a) Continental Africans? (b) Caribbean/South American Africans? (c) North American Africans and (d) Indian (Asia) Africans—such as the Sidi of Mumbai? The term "Africana" therefore encapsulates the "wide community" of Africa. It offers an openly conceptual framework to attract new and emerging ways of understanding the global Black experience.

The course therefore explores the interconnectedness of Black subject identities, experiences, issues, themes, as well as topics, and applies them dynamically to diverse locations of the Black world. Specifically, it sheds light on the global approach to the African Diaspora, showing how globalism underscores the distinctive role that Africa and African people have played in their contributions to world affairs. It seeks to demonstrate how Africana people have reclaimed their own "story", noting that "until lions have their own historians, tales of hunting will always glorify the hunter."

Thus, the methodology of this course uses a paradigm which identifies the multiple levels of Black reality over time. The basic facts and perspectives of the course come from the synthesis of three main sources: Africana intellectual tradition, the traditional academic disciplines (particularly the humanities and social sciences), and the Black Studies Movement. The course is also concerned with the development of academic skills. Through lectures, discussions, documentary and feature films, students are guided to learn how to read and interpret the scholarly output of the field of Africana Studies, master key concepts, definitions and terminologies. In addition, students learn to express their understandings and reactions to the subject matter both verbally (oral presentations) and in writing in the mode associated with the discipline of Africana Studies.

SOAN 235 Embodied African Aesthetic Foundations: West African Traditional and Contemporary Dance Praxis

Can be taken as an Elective
Prerequisite(s): None
Offered: Spring
Course Type: Lecture
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

This course will be a mix of movement labs and lecture conversations. Even through Zoom, movement concepts and aesthetics are translated, explored and deepened in our bodies. We practice dance strengthening and conditioning to prepare our bodies for West African Dance techniques. Innovative collaboration between student research projects is created in the course. Research projects are interdisciplinary, integrating student' Majors, Minors, and/or specific inquiries as they interconnect with African aesthetic foundations, principles, and the embodied knowledge of West African Traditional and Contemporary dance and culture. Everyone is welcome. All abilities have taken this course over the years and find research extending into West African Dance to be eye opening, meaningful, and a space for new knowledge production as well as deep identity exploration.

POLS 322 China-Africa Relations

Can be taken as an Elective
Prerequisite(s): None
Offered: Spring
Course Type: Lecture
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

The period from the 1990s has witnessed rapidly bourgeoning Sino-Africa ties, even though ties between them are not new. This is an interdisciplinary course intended to study the historical, economic, cultural, military, and political relations between the People's Republic of China and independent Africa. Employing a miscellany of primary source documents and secondary sources, the course will explore these interactions between China and Africa. We shall be particularly interested in a number of pertinent questions, including, does present-day Chinese engagement in Africa amount to a "new scramble for Africa" or "neo-imperialism"? Is China a hegemonic power in Africa? What are the implications of the "Beijing Consensus", and how has China's embrace of market reform in the 1980s changed her economic and ideological ties with Africa? This course also investigates the nascent role of Chinese companies and businesses in a fast-developing Africa. The goal is to augment students' comprehension of the dynamics of China-Africa relations in a progressively globalized world.

Leadership Seminar Series

The Leadership Seminar Series is a series of interdisciplinary seminars designed to promote self-awareness among Ashesi's students and to expose them to the ideas of great historical thinkers and contemporary leaders. Students will be asked to think broadly and to explore how they might use the examples set by other leaders to achieve their goals in their future professional lives. The leadership seminar series draws upon experts in different fields of corporate, social and academic life. Students must complete the full series in order to graduate from Ashesi University. The series consists of the following seminars:

SOAN 111 Leadership Seminar 1
Required for all BA, MIS & CS, ENG Majors
Prerequisite(s): Ashesi Success; Written and Oral Communication
Offered: Spring
Course Type: Seminar
Ashesi Units: 0.5; Credit Hours: 2; Hours per week classroom: 1.5; Hours per week discussion: 0
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 3 per week)

A program designed to enhance your overall success in college and in life. The most important objective of the program is personal empowerment: learning who you are as a college student, learning who you are as a human being and what you stand for, learning how to speak up when your values are in conflict with those around you, and learning what it takes for you to keep yourself balanced and on course to success. When you are empowered, your actions are more purposeful and your choices more deliberate. When you are empowered, you are more engaged and more motivated every day. And when you are empowered, you have a greater sense of well-being and enjoyment in life.

This course explores such questions as "What is good leadership? "What are the attributes of a Great Leader? and "What does a good leader do or not do? In this seminar, students will do readings of various historical and contemporary public and business leaders and explore the ethical dimensions of leadership. This is a half unit seminar taught in the format of discussions and assigned readings.

Course content addresses the purpose of leadership and the qualities of a great leader. Students will explore ethics and civic engagement in course readings and discussions. By comparing frameworks for leadership and ethical decision-making and applying those frameworks to leaders in a variety of contexts, students learn to analyze and evaluate the leadership they observe around them. Weekly writing assignments build students' skills in reflective writing. In-class discussions and debate build students verbal communication and presentation skills.

SOAN 221 Leadership Seminar 2
Required for all BA, MIS & CS, ENG Majors
Prerequisite(s): None
Offered: Fall
Course Type: Seminar
Ashesi Units: 0.5; Credit Hours: 2; Hours per week classroom: 1.5; Hours per week discussion: 0
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 3 per week)

This seminar probes the most fundamental questions about the good society: "What are the most fundamental rights of humanity? "What impact does national government have on the trajectory of nations? "What is the Social Contract - Rule of Law, and what impact does it have on civilizations?

After taking this seminar, students should have a deeper understanding of constitutional law and the concept of nations, whose leaders are expected to be servants of the people. This seminar also expands on the discussion of ethics, from corporate social responsibility to ethical issues in public office. Students will develop their skills in writing analytical and reflective papers.

SOAN 311 Leadership Seminar 3
Required for all BA, MIS & CS, ENG Majors
Prerequisite(s): None
Offered: Spring
Course Type: Seminar

Ashesi Units: 0.5; Credit Hours: 2; Hours per week classroom: 1.5; Hours per week discussion: 0
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 3 per week)

This seminar asks the questions: "What is the best way to organize the economic activity of a good society? "What is the proper definition of 'best' in the issue? "How do we best achieve a balance of liberty, efficiency, equality and community? This seminar is a natural progression from the previous discussion about Rights and The Rule of Law.

At the end of this seminar students should have a better understanding of the interplay between natural and civil rights on the one hand, and economic activity on the other. They will gain skills in analytical and reflective writing.

SOAN 411 Leadership Seminar 4
Required for all BA, MIS & CS, ENG Majors
Prerequisite(s): None
Offered: Fall, Spring
Course Type: Seminar
Ashesi Units: 1; Credit Hours: 4; Hours per week classroom: 3; Hours per week discussion: 1
Hours of Study outside of the class (reading, assignments, studying, projects, and so on: 8 per week)

This seminar is a capstone to the Leadership Seminar series and puts into practice many of the general concepts discussed in the previous seminars as well as courses taken at Ashesi. Service Learning helps students develop a sense of citizenship by giving them an opportunity to become engaged with their surrounding community, while also considering how they can make a positive impact on improving that community or solving its problems. The Leadership as Service Seminar is designed to extend this series beyond the classroom, get students engaged in the larger Ghanaian community, help them experience the impact that they can have in society, and thus develop a confidence that we hope will stay with them through their professional lives.

The course aims to: help you carve out your personal identity as a leader and to find yourself in this equation: personal integrity + desire for social change + relevant skills + creative problem-solving + courage = an Ashesi Leader; to help you understand servant leadership and enhance your ability to lead by example; to help you understand your role as a contributor to problem-solving and positive social change in your community; and to expose you to a variety of leaders, inspire, encourage and support you to be a great servant leader.

ECTS per Department

ECTS for Degree in Business Administration

Learning Activity	Learning Hours
Per Semester	
• In class instruction per course	42 hours *(3 hrs. X 14 weeks)*
• In class discussion associated with course	14 hours *(1 hr. X 14 weeks)*
• Out of class independent study associated with course instruction and discussion	112 hours *([42 hrs. + 14 hrs.] X 2)*
TOTAL per course	168 hours
There is a minimum of 33.5 courses in a program for a degree	5,628 hours *(168 hours X 33.5)*
Experiential Learning per Program	
• Foundations of Design and Entrepreneurship I	60 hours
• Foundations of Design and Entrepreneurship II	60 hours
• Internship	160 hours
• Leadership IV	50 hours *(10 hrs. pre and post fieldwork + 40 hrs. fieldwork)*
• Capstone	140 hours
TOTAL hours of learning per program	6098 hours
ECTS (using 1 ECT = 25 hours)	**Approx. 244 ECTS**

ECTS for Degree in Engineering

Learning Activity	Learning Hours
Per Semester	
• In class instruction per course	42 hours *(3 hrs. X 14 weeks)*
• In class lab associated with major course	28 hours *(2 hr. X 14 weeks)*
• In class discussion associated with general courses	14 hours *(1 hr X 14 weeks)*
• Out of class independent study associated with major course instruction and discussion	140 hours *([42 hrs. + 28 hrs.] X 2)*
• Out of class independent study associated with general course instruction and discussion	112 hours *([42 hrs. + 14 hrs.] X 2)*
TOTAL per major 16 courses	210 hours
TOTAL per general 18 courses	168 hours
There is a minimum of 16 major courses in a program for a degree	3,360 hours *(210 hours X 16)*
There is a minimum of 18 general courses in a program for a degree	3,024 hours *(168 hours X 18)*
Experiential Learning per Program	
• Foundations of Design and Entrepreneurship I	60 hours
• Foundations of Design and Entrepreneurship II	60 hours
• Internship	160 hours
• Leadership IV	50 hours *(10 hrs. pre and post fieldwork + 40 hrs. fieldwork)*
• Capstone	100 hours
TOTAL hours of learning per program	6,814 hours
ECTS (using 1 ECT = 25 hours)	**Approx. 273 ECTS**

ECTS for Degree in Computer Science and Information Systems

Learning Activity	Learning Hours
Per Semester	
• In class instruction per course	42 hours *(3 hrs. X 14 weeks)*
• In class discussion associated with major course	21 hours *(1.5 hrs. X 14 weeks)*
• In class discussion associated with general course	14 hours *(1 hrs. X 14 weeks)*
• Out of class independent study associated with major course instruction and discussion	126 hours *([42 hrs. + 21 hrs.] X 2)*
• Out of class independent study associated with general course instruction and discussion	112 hours *([42 hrs. + 14 hrs.] X 2)*
TOTAL per major course	189 hours
TOTAL per general course	168 hours
There is a minimum of 14 major courses in a program for a degree	2,646 hours *(189 hours X 14)*
There is a minimum of 19.5 general courses in a program for a degree	3,276 hours *(168 hours X 19.5)*
Experiential Learning per Program	
• Foundations of Design and Entrepreneurship I	60 hours
• Foundations of Design and Entrepreneurship II	60 hours
• Internship	160 hours
• Leadership IV	50 hours *(10 hrs. pre and post fieldwork + 40 hrs. fieldwork)*
• Capstone	100 hours
TOTAL hours of learning per program	6,352 hours
ECTS (using 1 ECT = 25 hours)	**Approx. 254 ECTS**

List of courses to be taken for graduation:

- Advanced Fundamentals [MAS]
  - Mathematical Tools I
  - Mathematical Tools II
  - Thermofluids
  - Computer Programming / Embedded Systems
  - Analog and Digital Electronics
  - Material Engineering
  - Signals and Systems
  - Dynamics
  - Statics and Solid Mechanics
  - Computational Methods
- Mechatronics [MSc]
  - Control Systems I
  - Control Systems II and Optimal Control
  - Introduction to Robotics and Mechatronics
  - System Identification and Modelling
  - Advanced Communication Systems and Internet of Things
  - Data Analysis and Machine Learning
- Engineering in Perspective [MSc]
  - Finance and Policy Making for Technology Innovation
  - Leading Teams
  - Corporate Responsibility and Sustainability
  - Reducing the Environmental Footprint of Society
  - Introduction to Development Economics
  - Sustainable Engineering
- Energy Systems [MSc]
  - Energy Systems I
  - Energy Systems and Mobility
- Production [MSc]
  - Manufacturing Processes
  - Process Engineering
  - Product Development
  - Reliability and Risk

MAS Curriculum (Year I)

Mathematical Tools I

This course covers mathematical concepts and techniques necessary to model, solve and discuss scientific problems - notably through ordinary differential equations. The key is the so-called mathematical modelling cycle, i.e. the translation of problems from outside of mathematics into mathematics, the study of the mathematical problems and the interpretation of the results in the original environment. The content will span from single-variable calculus and linear algebra to ordinary differential equations.

Mathematical Tools II

This course is continuation of Mathematical Tools I and the main focus is on multivariable calculus and partial differential equations. The goal of Mathematics II is to provide the mathematical foundations relevant for

this paradigm. Differential equations are by far the most important tool for modelling and are therefore a main focus of the course.

Thermofluids

This course introduces to the fundamentals of thermodynamics and fluid dynamics. In particular, it introduces the 1st and 2nd law of thermodynamics, the concept of energy, properties of compressible substances, and the kinetic theory of gases.

Embedded Systems and Computer Programming

An embedded system is some combination of computer hardware and software, either fixed in capability or programmable, that is designed for a specific function or for specific functions within a larger system. The course covers theoretical and practical aspects of embedded system design and includes a series of lab sessions. The focus of this lecture is on the design of embedded systems using formal models and methods as well as computer-based synthesis methods.

Digital Electronics

The course provides basic knowledge and methods to understand and to design digital circuits and systems. The content of the course includes digital and analogue signals and their representation, boolean algebra, circuit analysis and synthesis, the MOS transistor, CMOS logic, static and dynamic behaviour, tristate logic, Karnough-Maps, hazards, binary number systems, and coding. Moreover, will be also covered combinational and sequential circuits and systems (boolean algebra, K-maps, etc.), memory building blocks and memory structures, programmable logic circuits, finite state machines, and architecture of microprocessors.

Material Engineering

This module provides fundamental training in the behavior and manufacturing properties of materials as well as an introduction to materials selection and design considerations as practiced in industry, including related concepts such as Design for Manufacturing and “green” design. The objectives of the course include, the understanding of the societal implications of materials development, the appreciation of the challenges in materials selection, following the economical aspect of process selection, and grasp that any material is much more than its chemical composition.

Signals and Systems

Signals arise in most engineering applications. They contain information about the behavior of physical systems. Systems respond to signals and produce other signals. In this course, we explore how signals can be represented and manipulated, and their effects on systems. We further explore how we can discover basic system properties by exciting a system with various types of signals. The course will cover discrete-time signals and systems, Fourier- and z-Transforms, frequency domain characterization of signals and systems, system identification, time series analysis, and filter design.

Dynamics

This course aims at providing a graduate level introduction into the identification and condition assessment of structural systems. Upon completion of the course, the students will be able to: Test Structural Systems for assessing their condition, as this is expressed through stiffness, analyse sensor signals for identifying characteristic structural properties, such as frequencies, mode shapes and damping, based on noisy or incomplete measurements of the structural response, Establish relationships governing structural response (e.g. dynamics equations), Identify possible damage into the structure by picking up statistical changes in the structural "signature" (behavior).

Statics and Solid Mechanics

The course revisits the basic concepts of forces and mechanical power, and introduces methods for the analysis of statics problems: distributed forces, center of gravity, equilibrium, principle of virtual power, trusses, frames, forces and moments in beams and cables, friction. For the mechanical design of deformable bodies, the concepts of stress and deformations and introduced, thus allowing the formulation of the basic problem of continuum mechanics. Different constitutive models are discussed, including anisotropic linear elasticity, linear viscoelasticity, plasticity, viscoplasticity. The course will cover basic structural theories and their applications for the analysis of structural stability and fatigue problems.

Computational Methods

This module introduces numerical methods and techniques for solving initial boundary value problems in solid mechanics (heat conduction, static and dynamic mechanics problems of solids and structures), finite difference methods, indirect and direct techniques, variational methods, finite element (FE) method, FE analysis in small strains for applications in structural mechanics and solid mechanics.

MSc Curriculum: Semester-by-semester structure/schedule of course

Semester	Course Code	Module	Credit Hours (TPC)
Year 1			
Sem. 1: Sep – Jan	MECH 581	Analysis and Design of Control Systems	(2,2,3)
	MECH 521	Data Analysis and Machine Learning	(2,2,3)
	MECH 501	Leading Teams*	(2,0,2)
	MECH 531	Energy Systems	(2,2,3)
	MECH 503	Corporate Responsibility & Sustainability*	(2,0,2)
	MECH 511	Reliability and Risk	(2,2,3)
		Semester 1 total credit	16
Sem. 2: Jan – May	MECH 582	Optimal Control	(2,2,3)
	MECH 584	Robotics	(1,2,2)
	MECH 586	Mechatronics	(1,2,2)
	MECH 502	Reducing Societal and Environmental Footprint*	(2,0,2)
	MECH 532	Energy Systems and Mobility	(2,2,3)
	MECH 542	Process Engineering	(2,2,3)
	MECH 504	Finance and Policy for Technology Innovation*	(2,0,2)
		Semester 2 total credit	17

Year 2			
Sem. 1: Sep – Jan	MECH 681	System Identification and Modelling	(2,2,3)
	MECH 611 MECH 613	*Electives: (1 of these)* Sustainable Engineering Process Improvement & Optimization	(2,2,3)
	MECH 631 MECH 633	*Electives: (1 of these)* Advanced Communication Systems and Internet of Things Automation and Production Systems	(2,2,3)
	MECH 601	Development Economics	(2,0,2)
	MECH 613 MECH 651	*Electives: (1 of these)* Product Development Machine Tools (Jigs, Fixtures and Tools) Design	(2,2,3)
	MECH 641 MECH 645	*Electives: (1 of these)* Manufacturing Processes Food Production Technology	(2,2,3)
		Semester 1 subtotal	17
Sem. 2: Jan – May	MECH 690	Internship Master Thesis	4 6
		Total Program Credit	**60**

Course Descriptions of Mechatronics Engineering Programs

1) **Course Description:**

Provide short description of the content of the courses in the programme to include:

MECH 581 Analysis and Design of Control Systems (2,2,3)

a. *Objective*

The students will learn how to analyse systems and synthetize controllers for linear time invariant systems with one input and one output signal.

b. *Content*

- Modelling and linearization of dynamic systems with single input and output signals; State-space description; Analysis (stability, reachability, observability, etc.) of open-loop systems; Laplace transformation; Systems analysis in the frequency domain; Transfer functions and analysis of the influence of its poles and zeros on the system's dynamic behaviour. Frequency response; Analysis of closed-loop systems using the Nyquist criterion; Formulation of performance constraints; Specification of closed-loop system behaviour; Synthesis of elementary closed-loop control systems;

Proportional-Integral-Derivative (PID) controllers; Lead/lag compensation; Loop shaping; Discrete time state space representation and stability analysis

MECH 582 Optimal Control (2,2,3)

a. *Objective*

This course focuses on the theory and practice of advanced control techniques like state feedback, linear multi-variable control systems, and model predictive control.

b. *Content*

- Extension of the basic SISO ideas (time and frequency domain, controllability, observability, eigenvalues, poles, zeros, frequency response, etc.) to MIMO systems; Design of state feedback controllers in time domain; Pole allocation; Finite-horizon LQR; Infinite-horizon LQR; Design of state observers and observer-based controllers with state feedback; LQG approaches; Invariance; Nominal Model Predictive Control; Tracking Model Predictive Control; Stability and robustness analysis of Model Predictive Control; Robust Model Predictive Control

MECH 584 Robotics (1,2,2)

a. *Objective*

This to introduce the fundamentals of robotic systems including kinematics and dynamics as applied to manipulators and mobile robots.

b. *Content*

- Manipulators; Kinematics; Actuators, sensors and simple sensor processing algorithm; Trajectory planning; Motion control; Teleoperation, Master-slave systems - Supervisory control - Latency problems. Vision Systems; Path Planning

MECH 586 Mechatronics (1,2,2)

a. *Objective*

By the end of the course, the students will be able to independently choose, design and integrate these different building blocks into a working mechatronic system.

b. *Content*

Over the course, the lecture topics will include an overview of

- Robotics in the mechatronics context*;* An introduction to different types of sensors and their use*;* Data acquisition*;* Microcontrollers programming*;* Interfacing embedded computers with the real world*;* Digital signal filtering; Digital signal processing; Introduction to different types of actuators and their use*;* An overview of computer vision*;* Forward and inverse kinematics in mechatronics systems*;* Control strategies for mechatronics systems*;* Human-Robot interaction

MECH 681 System Identification and Modelling(2,2,3)

a. *Objective*

Learn how to mathematically describe a physical system or a process in the form of a model usable for analysis and control purposes.

b. *Content*

- Introduction to system modelling for control. First principles modelling; Lagrangian modelling; Energy-based methods. Model parametrization; Parameter estimation;

Data fitting and statistics; Least-squares estimation; Frequency-domain identification; Time-domain identification; Prediction error methods; ARX Models; Closed-loop identification

MECH 631 Advanced Communication Systems and Internet of Things (2,2,3)

a. *Objective*

The objective of this course is to provide an understanding of the principles for transport technologies for modern communications networks and architectures as well as the internet of things.

b. *Content*

The course will cover:

- protocol layers (both computing & IoT environment); delay, loss, throughput; routing algorithms; ethernet, switching, link layer; LANs, Constrained node networks; Internet protocol, Forwarding, Internet routing, routing policies, BGP challenges and solutions; TCP protocol; DNS, HTTP, IPv6; FieldBus, Modbus, Profibus, Profinet, Powerlink Ethernet, CANOpen; Constrained devices; Communications channels as adapted for IoT including 802.15.4 variants, (Zigbee, 6LoWPAN, WirelessHart, etc) NB-IoT, Bluetooth, Cellular, PLC, VLC et; Protocols suited for IoT:; Technologies for IoT: IoT sensors, MCU, communication modules, database technologies, data mining technologies and hosting, visualization; Programming for IoT Data Collection and Communication; Industrial Internet of Things protocols; IoT Security

MECH 521 Data Analysis and Machine Learning(2,2,3)

a. *Objective*

The course will introduce the foundations of learning and making predictions from data. We will discuss important machine learning algorithms used in practice, and provide hands-on experience in a course project.

b. *Content*

The course will cover:

- Linear regression; Overfitting; Cross-validation/bootstrap; Model selection; Regularization; [Stochastic] gradient descent; Linear classification; Logistic regression; Feature selection; Sparsity; Multi-class classification; Kernels and the kernel trick; Properties of kernels and applications to linear and logistic regression; K-nearest neighbour; Neural networks; Backpropagation; Regularization; Convolutional neural networks; Unsupervised learning; K-means; PCA; Neural network autoencoders; The statistical perspective (regularization as prior; loss as likelihood; learning as MAP inference); Statistical decision theory (decision making based on statistical models and utility functions); Discriminative vs. generative modelling (benefits and challenges in modelling joint vs conditional distributions); Bayes' classifiers (Naive Bayes, Gaussian Bayes; MLE); Bayesian approaches to unsupervised learning (Gaussian mixtures, EM).

MECH 504 Finance and Public Policy for Engineers (2,0,2)

a. *Objective*

This course will provide engineering students with basic knowledge on finance and public policy related to technology and innovation. It will have a particular focus on developing country-specific finance and policy aspects.

b. Content

- Evaluation and financing of capital projects. Methods taught include investment appraisal; cost effectiveness analysis, cost benefit analysis; technological forecasting, expert elicitation; cash flows for a project; time value of money; evaluation criteria for investment decisions, taxation; sensitivity, scenario and other decision analysis techniques; risk and return, sources of finance for projects, etc. Hands-on case studies, in which the students take an investor's or policy maker's role.

MECH 501 Leading Teams (2,0,2)

a. Objective

This course will provide an understanding of the basic HRM functions and their relationship to leadership, and how to manage team processes and diversity

b. Content

- The policies, practices, and systems that influence employees' behaviour, attitudes, and performance. Practical instruments supporting leadership functions; basic HRM functions and their relationship to leadership; instruments for selection, performance appraisal, compensation, management, and personnel development (from team leader's perspective); leadership requirements and success factors in leadership; fundamental processes in teams; how to manage team processes and diversity; Fundamentals of effective leadership and dynamics in teams. semester projects to apply HRM instruments in company contexts.

MECH 611 *Sustainable Engineering (2,2,3)*

a. Objective

Students will learn a holistic approach of sustainable development. Ecological, economic and social constraints will be presented and students will learn about methods for argumentation and tools for assessment) that influence our built environment. An objective is to address current challenges of climate change mitigation and resource depletion.

b. Content

The following topics give an overview of the themes that are to be worked on during the lecture:

- history and emergence of sustainable development; current understanding and definition of sustainable development. the role of cities, urbanisation and material resources (i.e. energy, construction material) in social economic and environmental sustainability; role of stakeholders, their motivations and constraints; how to evaluate challenges, identify deficits and define strategies to promote a more sustainable construction. Method 1: Life cycle assessment (planning, construction, operation/use, deconstruction). Method 2: Life Cycle Costing. Method 3: Labels and certification. Operation energy at building, urban and national scale, mobility and density questions, and embodied energy for developing and developed world. theory and application of current scientific pathways towards sustainable development.

MECH 601 Development Economics (2,0,2)

a. *Objective*

The goal of this course is to provide students with a basic understanding of both theories and empirics on poverty, growth and inequality. Based on this understanding, important policies for sustainable economic development and poverty reduction are discussed, with a focus on the role of technological innovations.

b. *Content*

- How development can be defined and measured – building on Sen's capability approach. Classical and endogenous growth theory and the role of capital, technological innovation, governance, education and health for economic development. How various forms of market failures lead to environmental destruction and extreme poverty and the policies that are needed by a state to confront it. The role of globalization for the future development of countries in sub-Saharan Africa will be discussed.

MECH 502 Reducing Societal and Environmental Footprint(2,0,2)

a. *Objective*

The objectives of this course are to (1) gain an overview of relevant questions in the area of international environmental politics from a social sciences viewpoint; (2) learn how to identify interesting/innovative questions concerning this policy area and how to answer them in a methodologically sophisticated way; (3) gain an overview of important global and regional environmental problems and how they could be solved.

b. *Content*

This course deals with how and why international cooperation in environmental politics emerges, and under what circumstances such cooperation is effective and efficient. Based on theories of international political economy and theories of government regulation various examples of international environmental politics to be discussed include:

- the management of international water resources; political responses to global warming; the protection of the stratospheric ozone layer; the reduction of long-range transboundary air pollution; protection of biodiversity; how to deal with plastic waste; the prevention of pollution of the oceans, etc.

MECH 503 Corporate Responsibility & Sustainability (2,0,2)

a. *Objective*

This course introduces approaches to corporate social responsibility. It will address questions such as -What is the responsibility of companies to contribute to society, if any? How can companies integrate their responsibility into the business model and along the supply chain?

b. *Content*

The course will cover international soft-laws or self-regulation instruments, and discuss the challenges companies face when implementing corporate social responsibility in business operations.

MECH 531 Energy Systems (2,2,3)

a. *Objective*

Students learn the potential and limitations of renewable energy technologies and their contribution towards sustainable energy utilization.

b. Content

Engineering aspects of energy conversion for

solar thermal, solar photovoltaics, biomass, wind, geothermal, hydro, and waste-to-energy technologies. Technologies for energy optimization

MECH 532 Energy Systems and Mobility (2,2,3)

a. Objective

This course provides and introduction to current and future propulsion systems behaviour, focussing on energy generation and utilisation. It addresses electrical aspects of energy engineering and topics in renewable energy. Moreover, it will also cover system optimization and controller design for vehicles.

b. Content

- Physical description and mathematical models of components and subsystems;Power utilization;Power electronics;Propulsion;load control;supercharging, emissions;drive train components;HV & LV power distribution

MECH 641 Manufacturing Processes (2,2,3)

a. Objective

The course discusses fundamental terms of production engineering and process chain planning.

b. Content

- Basic principles of manufacturing techniques; functionality of a manufacturing shop. Plastic deformation- and separative- manufacturing processes; laser machining (welding and cutting), and their layouts, product defining properties; limitations of applications such as the associated workshop facilities; principles of the industrial measurement technique; mechatronics concepts in machine tool construction; quality assurance,

MECH 542 Process Engineering (2,2,3)

a. Objective

Students should be able to evaluate and design biological, chemical (or similar) processes, and develop simple mathematical models to simulate the processes.

b. Content

- biological and chemical processes used (eg in wastewater treatment, organic waste management, and biological resource recovery. Also an overview of other common industrial processes. Fundamental principles of biological and chemical processes; process design based on kinetic and stoichiometric principles, e.g., anaerobic digestion for biogas production and aerobic wastewater treatment. Process technologies, equipment and systems; Industrial Processes; Process Technolgy operations; Quality, Safety, Health and Environment

MECH 613 Product Development (2,2,3)

a. Objective

The course introduces students to the product development process. Students will in a team, explore the early phases of conceptual development and product design, from ideation and concept generation through to hands-on prototyping.

b. Content

- Introduction to product development and engineering design; product planning and social-economic-technology (SET) factors; user-centred design and product specification; concept generation and selection methods; system design and embodiment design; hands-on prototyping and prototype planning; material selection in engineering design; product lifecycle and sustainability; design for manufacture and design for additive manufacture.

MECH 511 Reliability and Risk(2,2,3)

a. Objective

Students will be able to model complex technical systems and critical infrastructures including their dependencies and interdependencies with appropriate numerical methods. At the end, they will be able to propose design improvements and protection/mitigation strategies to reduce risks and vulnerabilities of these systems.

b. Content

Preamble: Modern technical systems and critical infrastructures are complex, highly integrated and interdependent. Examples of these are highly integrated energy supply, energy supply with high penetrations of renewable energy sources, communication, transport, and other physically networked critical infrastructures that provide vital social services. As a result, standard risk-assessment tools are insufficient in evaluating the levels of vulnerability, reliability, and risk. This course offers suitable

- Analytical models and computational methods to evaluate levels of vulnerability, reliability, and risk with scientific accuracy. Introduction to complex technical systems and critical infrastructures; basics of the Markov approach to system modelling for reliability and availability analysis; Monte Carlo simulation for reliability and availability analysis, Markov Chain Monte Carlo for applications to reliability and availability analysis, dependent, common cause and cascading failures; complex network theory for the vulnerability analysis of complex technical systems and critical infrastructures; basic concepts of uncertainty and sensitivity analysis in support of the analysis of the reliability and risk of complex systems under incomplete knowledge of their behaviour,