**Bayero University, Kano (BUK)**

**Faculty of Engineering**

# Department Electrical Engineering

# B. Eng. Electrical

# Proposed 30% addition to the CCMAS Course Structure/Summary

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **LEVEL 100** | | | | | |
| **CODE** | **COURSE NAME** | **Unit** | **Status** | **LH** | **PH** |
| BUK-EEE 101 | Engineering Mathematics III (Vectors, Matrix and Geometry) | 3 | C | 45 | - |
| BUK-EEE 102 | General Physics III | 2 | C | 30 | 15 |
| BUK-EEE 103 | Basic Statistics | 3 | C | 45 | - |
|  | **Total** | **8** |  |  |  |

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| --- | --- | --- | --- | --- | --- |
| **LEVEL 200** | | | | | |
| **CODE** | **COURSE NAME** | **Unit** | **Status** | **LH** | **PH** |
| BUK-EEE 201 | Introduction to Signal Processing | 3 | C | 30 | 45 |
|  | **Total** | **3** |  |  |  |

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| --- | --- | --- | --- | --- | --- |
| **LEVEL 300** | | | | | |
| **CODE** | **COURSE NAME** | **Unit** | **Status** | **LH** | **PH** |
| BUK-EEE 301 | System Modelling and Analysis | 3 | C | 30 | 45 |
| BUK-EEE 302 | Digital Electronics | 2 | C | 30 | 15 |
| BUK-EEE 303 | Communications Principles | 2 | C | 30 | 15 |
| BUK-EEE 304 | Electromagnetic Theory | 2 | C | 30 | 15 |
| BUK-EEE 305 | Electrical Power Systems | 2 | C | 30 | 15 |
| BUK-EEE 306 | Sensors and Actuators | 2 | C | 30 | 15 |
|  | **Total** | **13** |  |  |  |

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| --- | --- | --- | --- | --- | --- |
| **LEVEL 400** | | | | | |
| **CODE** | **COURSE NAME** | **Unit** | **Status** | **LH** | **PH** |
| BUK-EEE 401 | Control Engineering | 3 | C | 30 | 45 |
| BUK-EEE 402 | Power Electronics | 3 | C | 30 | 45 |
| BUK-EEE 403 | Artificial Intelligence and Applications | 2 | C | 30 | 15 |
| BUK-EEE 404 | Integrated Systems Design Project | 3 | C | 30 | 45 |
| BUK-EEE 405 | AC Machines | 3 | C | 30 | 45 |
|  | **Total** | **14** |  |  |  |

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| --- | --- | --- | --- | --- | --- |
| **LEVEL 500** | | | | | |
| **CODE** | **COURSE NAME** | **Unit** | **Status** | **LH** | **PH** |
| BUK-EEE 501 | Analog Electronics Laboratory | 3 | C | 30 | 45 |
| BUK-EEE 502 | Power Electronics Laboratory | 3 | C | 30 | 45 |
| BUK-EEE 503 | Electric Drives | 2 | C | 30 | 15 |
| BUK-EEE 504 | Final Year Project | 6 | C | 30 | 45 |
|  | *Elective* | 2 | E | 30 | 15 |
|  | **Total** | **16** |  |  |  |
|  | **Grand Total** | **49** |  |  |  |

# BUK-EEE 101 Elementary Mathematics III (Vectors, Coordinate Geometry and Dynamics) (2 Units; Core; LH = 30)

## Senate-approved relevance

Training of high-quality graduates that are well-skilled and knowledgeable in the required mathematical skills in Nigeria are in line with BUK’s mission to address African developmental challenges in producing qualified graduates in electrical engineering.

## Overview

Vectors coordinate, geometry and dynamic is a vital course that prepares the graduate in agricultural and biosystems engineering to be able to handle and improve on the infrastructural deficit for sustainable development. This highlights the importance of preparing students in agricultural and biosystems engineering with the knowledge and skills on how to solve problems that they will encounter in the course of their training.

This course is designed to introduce and prepare students ahead of various agricultural and biosystems engineering courses in design, process, and production. The importance of the course lies in meeting the need in achieving sustainable development goals (SDGs) numbers 1 and 2 in the areas of reducing poverty and zero hunger respectively. The objectives of the course, learning outcomes, and contents are provided to address this need.

## Objectives

In this course students will learn:

1. solve some vectors in addition and multiplication

2. calculate force and momentum

3. explain types of vectors, a geometrical representation of vectors, and components of

vectors

4. solve differentiation and integration of vectors

5. illustrate the linear dependence of vectors and its simple application

6. demonstrate dimensional coordinates systems

7. analyze the equation of a circle, tangent, and normal to a circle.

8. describe the properties of parabola, ellipse, hyperbola, straight lines, and planes in

space;

9. describe and justify force, momentum, laws of motion under gravity, projectiles,

resisted vertical motion, angular momentum, and simple harmonic motion

10. describe elastic string, simple pendulum, and impulse.

11. analyze the impact of two smooth spheres and of a sphere on a smooth surface.

## Learning Outcomes

On the successful completion of this course, the student should be able to:

1. explain at least two (2) types of vectors, a geometrical representation of vectors,

components of vectors

2. illustrate the linear dependence of vectors and their simple applications clearly

3. demonstrate dimensional coordinates systems,

4. analyze the equation of a circle, tangent, and normal to a circle.

5. describe the properties of parabola, ellipse, hyperbola, straight lines, and planes in

space;

6. describe and justify force, momentum, laws of motion under gravity, projectiles,

resisted vertical motion, angular momentum, and simple harmonic motion

7. describe elastic string, simple pendulum, and impulse.

8. Analyse the impact of two smooth spheres and of a sphere on a smooth surface.

## Course Contents

Types of vectors: points, line, and relative vectors. Geometrical representation of vectors in 1-3 dimensions. Addition of vectors and multiplication by a scalar. Components of vectors in 1-3 dimensions. Direction cosines. Linear independence of vectors. Point of division of a line. 4 Scalar and vector products of two vectors. Simple applications. Two-dimensional coordinate geometry. Straight lines. The angle between two lines, distance between points. Equation of a circle, tangent and normal to a circle. Properties of parabola ellipse. Hyperbola straight lines and planes in space. Direction cosines. The angle between lines and between lines and planes. A distance of a point from a plane. Components of velocity and acceleration of a particle moving in a plane, force, momentum. Laws of motion under gravity, projectiles, and resisted vertical motion. Angular momentum. Simple harmonic motion. Elastic string. Simple pendulum, and impulse. The impact of two smooth spheres and of a sphere on a smooth surface.

## Minimum Academic Standards

Electrical engineering programme’s NUC-MAS requirement facilities.

# BUK-CPE 102 General Physics III (2 Units; Core; LH = 30)

## Senate-approved relevance

Training of high-quality graduates who are highly knowledgeable in the fundamentals of physics and which will equip them with broad knowledge of Physics foundation and electronics to address the challenges of the 21st century, which is in agreement with BUK’s mission to address African developmental challenges by producing mechanical engineering graduates that can produce energy efficient electronic systems to address Africa’s energy challenges.

## Overview

This course is design to provide basic foundation of Physics that is dealing with electricity and magnetism and underlining mathematical concepts that underpin a better understanding of the course.

The course is an introduction to electromagnetic fields and forces and the overall goal is to use the scientific method to come to understand the enormous variety of electromagnetic phenomena in terms of a few relatively simple laws.

## Objectives

In this course students will learn:

1. describe the ways in which various concepts in electromagnetism come into play in particular situations.

2. represent these electromagnetic phenomena and fields mathematically in those situations.

3. use Coulomb’s law, Gauss’s law, and electric potential to determine electrostatic properties of charge distributions for different applications.

4. understand the physical meaning and application of Maxwell’s equations.

5. understand the DC circuits and the characteristics of AC systems.

## Learning Outcomes

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

1. describe the electric field and potential, and related concepts, for stationary charges.
2. calculate electrostatic properties of simple charge distributions using Coulomb’s law, Gauss’s law, and electric potential.
3. describe and determine the magnetic field for steady and moving charges.
4. determine the magnetic properties of simple current distributions using Biot-Savartand Ampere’s law;
5. describe electromagnetic induction and related concepts and make calculations using Faraday and Lenz’s laws.
6. explain the basic physical of Maxwell’s equations in integral form.
7. evaluate DC circuits to determine the electrical parameters; and

determine the characteristics of AC voltages and currents in resistors, capacitors, and inductors.

## Course Contents

Forces in nature. Electrostatics (electric charge and its properties, methods of charging). Coulomb’s law and superposition. Electric field and potential. Gauss’s law. Capacitance. Electric dipoles. Energy in electric fields. Conductors and insulators. DC circuits (current, voltage and resistance. Ohm’s law. Resistor combinations. Analysis of DC circuits. Magnetic fields. Lorentz force. Biot-Savart and Ampère’s laws. Magnetic dipoles. Dielectrics. Energy in magnetic fields. Electromotive force. Electromagnetic induction. Self and mutual inductances. Faraday and Lenz’s laws. Step up and step down transformers. Maxwell's equations. Electromagnetic oscillations and waves. AC voltages and currents applied to inductors, capacitors, and resistance.

## Minimum Academic Standards

General Physics III (Electricity & Magnetism) is as contained in the NUC CCMAS.

It requires Physics Practical Laboratory.

# BUK-CPE 103 Basic Statistics (3 Units; Core; LH = 30)

## Senate-approved relevance

Training of high-quality graduates that are well-skilled and knowledgeable in handling and analysing statistical data is in line with BUK’s mission to address African developmental challenges in producing graduates in agricultural and biosystems engineering. Relevance is seen in agricultural and biosystems engineers from BUK because all agricultural activities use the statistical principles to solve challenges during food production.

## Overview

Statistics is a vital approach used in handling data obtained from different processes, operations, and experiments in agricultural and biosystems engineering. It is designed to introduce and expose students to various statistical tools required in computing and analysing data. The course is also designed to build the capacity of students in the area of data analysis formulating problem solving approach in the midst of an abundance of untapped raw materials.

The importance of the course lies in meeting the need in achieving sustainable development goals (SDGs) numbers 1 and 2 in the areas of reducing poverty and zero hunger respectively. The objectives of the course, learning outcomes, and contents are provided to address this need.

## Objectives

The objectives of the course are to:

1. define statistics and identify various sources of data

2. explain measurement of location and dispersion in grouped and un-grouped data

3. explain exponential, elements of a probability distribution; normal, binomial, Poisson,

geometrics, and negative binomial distributions

4. describe estimate and tests the hypothesis concerning the parameters of distributions

5. analyze regression and correlation models

6. construct questionnaires and simple index numbers

7. apply statistical principles in agricultural and biosystems engineering

## Learning Outcomes

On completion of the course, students should be able to:

1. identify at least five (5) various sources of statistical data

2. measure location and dispersion in grouped and un-grouped data

3. evaluate exponential, elements of a probability distribution; normal, binomial, Poisson,

geometrics, and negative binomial distributions

4. evaluate estimate and test hypothesis concerning the parameters of distributions

5. analyze at least a regression and a correlation model

6. construct at least a questionnaire and a simple index number

7. apply at least a statistical principle in agricultural and biosystems engineering.

## Course Contents

Definition of statistics. Statistical data sources, collection and analysis. Types of statistics.

Descriptive statistics and inferential statistics. Measurement of location in grouped and ungrouped data. Skewness and Kurtosis. Measure of central tendencies: mean, mode, median variance, and standard deviation for grouped and un-grouped data. Time series and

demographic measures and index numbers. Construction of questionnaires and simple index numbers. Use of random numbers and statistical tables. Estimation and test of hypothesis. Analysis and presentation of statistical data. Curve fitting and goodness-of-fit tests. Analysis of regression and correlation models. A measure of dispersion in grouped and un-grouped data. Deterministic and statistical (Stochastic) Models. Elements of a probability distribution. Binomial Distribution, Normal Distribution. Geometric Distributions. Poisson distribution. Negative Binomial Distributions. Exponential Distribution. Reliability function. Estimation and tests of hypothesis concerning the parameters of the distributions. Generation of statistical. events from set-theory and combinatorial methods. Elementary principles of probability. Types and distribution of random variables. The binomial, Poision, hypergeometric and normal distributions. Expectations and moment, random variables. Probability sampling from table of random numbers. Applications of statistical principles in agricultural and biosystems engineering

## Minimum Academic Standards

NUC CCMAS**.**

# BUK-EEE 201 Introduction to Signal Processing, (3 Units; Core; L = 30; P = 45)

## Senate-approved relevance

Training of high-quality graduates who are highly knowledgeable in the fundamentals of signal processing and which will equip them with the requisite skills for the development of algorithms that is the backbone of computer communication and processing of digital data. This is in agreement with BUK’s mission to be forefront in digital world and lead Africa in current technologies.

## Overview

A signal processing course typically covers the theory, techniques, and applications of processing signals in various domains, such as time, frequency, and spatial domains. Signal processing is a fundamental field in electrical engineering, computer science, and related disciplines, and is used in a wide range of applications, including telecommunications, audio and image processing, medical imaging, radar, and more.

Introduce the mathematical tools for analysing signals and systems in the time and frequency domains, and provide a basis for applying these techniques in control and communications engineering. Focusing on the use of Fourier and related transforms to analyse and process electrical signals in one and two dimensions.

## Objectives

In this course students will learn:

1. Provide a thorough and complete introduction to the subject of modern digital signal processing;
2. Emphasise the links between the theoretical foundations of the subject and the essentially practical nature of its realisation;
3. Encourage and understand through the use of algorithms and real-world examples;
4. Provide useful skills through detailed practical laboratories, which explore both off-line and real-time DSP software and hardware

## Learning Outcomes

On the successful completion of this course, the student should be able to:

1. Analyse and develop simple mathematical models for representing signals and systems;
2. Convert time domain models into frequency, Laplace and Z domain models of signals and linear time-invariant systems (continues and discrete) and vice versa;
3. Compute the fast Fourier transform (FFT) of signal in Python or MATLAB.
4. Interpret the z-domain transfer function of a discrete-time system and design discrete time filters in the z domain using the pole-zero method;
5. Design and implement simple finite impulse response (FIR) and infinite impulse response (IIR) discrete-time filters in microcontrollers.

## Course Contents

*Introduction to Signals and Systems*: Continuous-Time Signals, Continuous-Time Convolution, Linear Time-Invariant Systems, properties of LTI Systems.

*Discrete-Time signals*: Sampling Theory, Linear systems, discrete signals (impulse, step, exponential), Discrete-Time Convolution, Fourier-Transform; DFT and FFT.

*Digital filters*: Advantages and disadvantages over analogue filters. Binomial transformation, FIR and IRR digital filters design.

Applications of DSP: STFT, speech; 2D signal processing-image filtering deconvolution; communication systems

## Minimum Academic Standards

Computer Lab with high performance PC.

# BUK-EEE 301 System Modelling and Analysis, (3 Units; Core; L = 30; P = 45)

## Senate-approved relevance

Training of high-quality graduates who are highly knowledgeable in modelling and analysis of mathematical representation of real-life models. This will equip the students with the requisite skills for the development of algorithms for controlling, predicting and design of systems. This is in agreement with BUK’s mission to be forefront in digital world and lead Africa in current technologies.

## Overview

System Modelling and Analysis is a course that focuses on the principles and techniques used in modelling and analysing complex systems, which could be physical, social, or technological in nature. The course typically covers topics such as systems thinking, system dynamics, modelling techniques, simulation, and optimization. It is commonly offered as a course in engineering, computer science, operations research, or management programs.

Overall, System Modelling and Analysis is a course that provides students with a foundation in systems thinking, modelling, and analysis techniques, which are essential for understanding and managing complex systems in various fields. The course equips students with the skills to analyze and optimize systems, make informed decisions, and address real-world problems effectively.

## Objectives

In this course students will learn:

1. Develop mathematical models of systems using first principle
2. Given input and output data develop a model of systems
3. Convert model from one domain to another
4. Analyse system behaviour from model

## Learning Outcomes

On the successful completion of this course, the student should be able to:

1. Know the importance of modelling and simulation in Engineering.
2. Derive the models of electrical, mechanical, fluid, thermal and electromechanical systems in time and Laplace domain.
3. Simulate the behaviors of the above systems in computer programs like python or MATLAB/Simulink.
4. Use Z-domain to analyse systems.
5. Analyse the behaviour and response of first and second order systems.
6. Model black box systems using system identification
7. Model black box systems using feedforward ANN.

## Course Contents

Introduction to system models, uses, applications. Advantages and importance of simulations.

Basic concept of *White box, Black box* and *Grey box* modelling technique.

*Types of models*; *Dynamics models, Linear models, Nonlinear models, Time domain models, Frequency domain models, LTV, LTI models* (Only definition and basics required, not fully detailed). *Transfer function models: transfer function* concept, i.e. Poles and zeros, system order, system type, stability.

*Laplace Domain*: Introduction to Laplace Domain and its relationship to system modelling. Modelling of electrical, mechanical, fluid, thermal and electromechanical systems in Laplace domain and simulation of the system behaviour. Input signals; impulse, unit step, ramp, sinusoidal signals.

*Z-domain*: Definitions, Z-transform properties, zero order holder, pole and zero plots in Z-plane, conversion from S-domain to Z-domain. Z-plane roots and stability, difference equation.

System responses of *first order* systems, time constant, D.C gain, equation in Laplace and time domain. System responses *second order* systems, transient and steady state response, rise time, delay time, peak over shoot, settling time, natural frequency and damping ratio.

*Introduction to System Identification:* modelling of first order system via identification. DC motor parameter identification.

*Introduction to ANN model*

## Minimum Academic Standards

Computer Lab with high performance PC.

# BUK-EEE 302 Digital Electronics, (3 Units; Core; L = 30; P = 45)

## Senate-approved relevance

Training of high-quality graduates who are highly knowledgeable in modelling and analysis of mathematical representation of real-life models. This will equip the students with the requisite skills for design of digital systems. This is in agreement with BUK’s mission to be forefront in digital world and lead Africa in current technologies.

## Overview

Digital Electronics is a field of electronics that focuses on the study of digital circuits and systems, which use discrete and finite values (typically 0s and 1s) to represent and manipulate information. Digital electronics is a foundational subject in electrical engineering and computer science, and it forms the basis for modern digital technologies such as computers, communication systems, and embedded systems.

Digital Electronics is a fundamental course that provides students with a solid understanding of the principles and techniques used in designing, analysing, and troubleshooting digital circuits and systems. It forms the foundation for many advanced topics in electrical engineering and computer science, such as computer architecture, digital signal processing, and embedded systems design, and is essential for anyone interested in working.

## Objectives

In this course students will learn:

1. To introduce the fundamental concepts of digital electronics and digital circuits.
2. To develop the ability to analyze and design digital circuits.
3. To understand the operation and design of basic digital building blocks, such as gates, flip-flops, counters, and registers.
4. To learn the methods for minimizing Boolean expressions and implementing digital logic circuits.
5. To understand the behavior of combinational and sequential circuits and their applications in digital systems

## Learning Outcomes

On the successful completion of this course, the student should be able to:

1. Understand the principles of digital electronics and their applications.
2. Analyze and design digital circuits using Boolean algebra and logic gates.
3. Design and implement combinational and sequential circuits.
4. Minimize Boolean expressions and design logic circuits using various techniques.
5. Understand the operation and design of basic digital building blocks such as flip-flops, counters, and registers.
6. Apply digital circuits in real-world applications such as digital signal processing, communication systems, and digital control systems.

## Course Contents

Digital systems and their applications, Number systems and codes, Decimal, binary, octal, and hexadecimal number systems, Binary codes (BCD, Gray code, etc.), Boolean algebra and logic gates, Boolean algebra and its laws, Logic gates and their characteristics, Boolean functions and truth tables.

Combinational circuits: Combinational logic circuits, Adders, subtractors, multiplexers, demultiplexers, encoders, and decoders

Sequential circuits: Sequential logic circuits, Flip-flops (SR, D, JK, T), registers, and counters

Minimization techniques, Karnaugh maps and Boolean algebraic manipulation, Quine-McCluskey method,

Digital system design: Design of digital systems using basic building blocks, Timing diagrams and state diagrams.

Applications of digital electronics: Digital signal processing, Digital communication systems, Digital control systems

## Minimum Academic Standards

Computer Lab with high performance PC.

# BUK-EEE 303 Communication Principles, (3 Units; Core; L = 30; P = 45)

## Senate-approved relevance

Training of high-quality graduates who are highly knowledgeable in modelling and analysis of mathematical representation of real-life models. This will equip the students with the requisite skills for design of communication systems. This is in agreement with BUK’s mission to be forefront in digital world and lead Africa in current technologies.

## Overview

A course on Communication Principles typically covers the fundamental concepts and theories related to communication systems and networks. Communication is a crucial aspect of modern society, and this course provides students with a solid understanding of the principles and techniques used in transmitting, receiving, and processing information in various communication systems.

The course provides students with a solid foundation in the principles and techniques used in designing, analysing, and troubleshooting communication systems. It is essential for anyone interested in the field of communication engineering, telecommunications, or networking.

## Objectives

In this course students will learn:

1. To provide students with an understanding of the fundamental principles and techniques used in electrical communication systems
2. To explore the transmission, reception, and processing of signals in communication systems
3. To introduce students to analog and digital communication and their differences
4. To familiarize students with modulation and coding techniques used in communication systems
5. To provide students with an understanding of the principles of wireless communication.

## Learning Outcomes

On the successful completion of this course, the student should be able to:

1. Demonstrate an understanding of the fundamental principles and techniques used in electrical communication systems
2. Explain the transmission, reception, and processing of signals in communication systems
3. Differentiate between analog and digital communication and their respective advantages and disadvantages
4. Understand modulation and coding techniques used in communication systems
5. Analyze and design communication systems using the principles of wireless communication.

## Course Contents

Models of telecommunication system. The concept of information volume. Characteristics of analogue audio and video signals. Analogue modulation techniques and their implementation: amplitude and angle modulation, Frequency Division Multiplexing. Digitization of analogue signals. Binary system. Arithmetic operations on binary numbers. Modulo 2 arithmetic. Pulse code modulation (PCM), sampling, quantization, coding. Delta and differential pulse code modulation. Synchronous and asynchronous, static and dynamic time division multiplexing. Plesio-synchronous digital hierarchy, primary group, secondary group, groups of higher levels. Synchronous digital hierarchy. Multiplexing PDH signals into SDH STM-1 transport module. Transmission media. Optical fibres: single mode, multimode. Optical cables. Wavelength division multiplexing (WDM): Dense wavelength division multiplexing (DWDM).

## Minimum Academic Standards

Computer Lab with high performance PC.

# BUK-EEE 304 Electromagnetic Theory, (3 Units; Core; L = 30; P = 45)

## Senate-approved relevance

Training of high-quality graduates who are highly knowledgeable in modelling and analysis of mathematical representation of real-life models. This will equip the students with the requisite skills for design of communication systems. This is in agreement with BUK’s mission to be forefront in digital world and lead Africa in current technologies.

## Overview

Electromagnetic Theory is a foundational course that provides students with a deep understanding of the principles of electromagnetism and their practical applications. This course is essential for students pursuing a career in electrical engineering or physics, as well as those interested in pursuing advanced study in these fields.

In addition, the course covers practical applications of electromagnetic theory, such as the design of electrical circuits, telecommunications systems, and radar systems. Students will learn how to apply the principles of electromagnetic theory to solve problems in these fields.

## Objectives

In this course students will learn:

1. To provide students with a fundamental understanding of electromagnetism and its applications
2. To introduce students to the principles of vector calculus and their applications in electromagnetism
3. To familiarize students with the properties of electric and magnetic fields and their interactions
4. To develop students' ability to apply the principles of electromagnetism to solve real-world problems
5. To prepare students for advanced study in electromagnetism and related field.

## Learning Outcomes

On the successful completion of this course, the student should be able to:

1. Understand the fundamental principles and laws governing electromagnetic phenomena
2. Apply vector calculus to solve problems related to electromagnetism
3. Analyze electric and magnetic fields and their interactions
4. Solve real-world problems using the principles of electromagnetism
5. Demonstrate an understanding of the practical applications of electromagnetism in fields such as electrical engineering, physics, and telecommunications.

## Course Contents

Review of electromagnetic laws in integral form, Gauss’s Law, Ampere’s and Faraday’s Laws; Electrostatic fields due to distribution of charge, magnetic fields in and around current carrying conductors, time-varying magnetic and electric fields; conduction and displacement current; Maxwell’s equation (in rectangular co-ordinates and vector-calculus notation): derivation of Maxwell’s equations; electromagnetic potential and waves; Poynting vector; boundary conditions; wave propagation in good conductors, skin effect; plane waves in unbounded dielectric media.

## Minimum Academic Standards

Computer Lab with high performance PC.

# BUK-EEE 305 Electrical Power Systems, (3 Units; Core; L = 30; P = 45)

## Senate-approved relevance

Training of high-quality graduates who are highly skilled in power generation, transmission and distribution. This will equip the students with the skills needed for design and developing power transmission and distribution networks. This is in agreement with BUK’s mission to be forefront in digital world and lead Africa in current technologies.

## Overview

Electrical Power Systems is a course that covers the generation, transmission, distribution, and utilization of electrical energy. This course explores the components of electrical power systems, including generators, transformers, transmission lines, distribution systems, and motors.

Electrical power systems are critical infrastructure that enable the generation, transmission, and distribution of electric power to meet the needs of modern society. A course on electrical power systems provides students with a solid understanding of the principles, technologies, and challenges involved in designing, operating, and managing electric power systems Students will also learn about power system stability, protection, and control.

## Objectives

In this course students will learn:

1. To provide students with an understanding of the components of electrical power systems and their functions
2. To introduce students to the principles of power generation, transmission, distribution, and utilization
3. To familiarize students with power system stability, protection, and control
4. To develop students' ability to analyze and design electrical power systems
5. To prepare students for careers in electrical engineering, energy management, and related fields.

## Learning Outcomes

On the successful completion of this course, the student should be able to:

1. Understand the components and functions of electrical power systems
2. Explain the principles of power generation, transmission, distribution, and utilization
3. Analyze power system stability, protection, and control
4. Design and analyze electrical power systems
5. Apply the principles of electrical power systems to solve real-world problems in energy management and related fields.

## Course Contents

Introduction to Electrical Power Systems: Overview of power system components, functions, and configurations.

Power Generation: Power plant operation, generator modelling, and load management.

Transmission Systems: AC and DC transmission, line parameters, power flow analysis, and fault analysis.

Transformers: Single-phase and three-phase transformers, equivalent circuits, and transformer connections.

Distribution Systems: Feeder types, voltage regulation, substation design, and underground cables.

Protection and Control: Relay protection, circuit breakers, switchgear, and control systems.

Power Quality: Voltage sag, flicker, harmonics, and mitigation techniques.

Renewable Energy: Integration of renewable energy sources into power systems.

## Minimum Academic Standards

Power Lab with high performance PC.

# BUK-EEE 306 Sensors and Actuators, (2 Units; Core; L = 30; P = 30)

## Senate-approved relevance

Training of high-quality graduates who are highly knowledgeable in sensors and actuators. This will equip the students with the skills needed for design and developing different sensors with different applications. This is in agreement with BUK’s mission to be forefront in digital world and lead Africa in current technologies.

## Overview

A Sensors and Actuators course is typically offered in engineering and related fields, and focuses on the principles, design, and applications of sensors and actuators in various systems and devices. Sensors are devices that detect physical, chemical, or biological quantities and convert them into electrical signals, while actuators are devices that control or manipulate physical processes or systems based on electrical signals.

This course provides students with the fundamental knowledge and skills necessary to understand, analyze, and design sensors and actuators for different applications, also provides students with the knowledge and skills to understand, design, and implement sensors and actuators in different applications.

## Objectives

In this course:

1. Student should do practical design for suitable sensors for a specific sensing application.
2. Enable students to apply fundamental design rules to achieve required performance instrumentation devices and systems.
3. Create analytical design and development solutions for actuators

## Learning Outcomes

On the successful completion of this course, the student should be able to:

1. Describe the principles of operation of the main types of sensors
2. Analyse the specifications and main characteristics of various types of sensors.
3. Utilise the merits of various types of sensors for a wide range of application systems
4. Select appropriate designs for simple electronic sensor interface systems.
5. Interface drive circuits to actuators

## Course Contents

Fundamental Sensor Concepts: Sensor characteristics: transfer function, range and sensitivity, errors and calibration, accuracy and precision, linearity, hysteresis.

Sensors for position, displacement, level and flow, occupancy, sensors for velocity, acceleration, force and strain, sensors for radiation: sources, detectors, optical circuit components, sensors for temperature: reference points, thermos resistive and thermoelectric sensors.

Sensor interfaces: bridge circuits, capacitance–to-voltage and light-to-voltage converters

Sensing electronic circuits: input characteristics, excitation circuits, overview of amplifiers, amplifier noise (mechanisms, noise figure, noise model).

*Electrical Actuators*: Review of Electrical Motors and their types, Motor Equations, Drivers, and Control of DC Motors and Stepper Motors.

*Hydraulic Actuators*: Pumps and its different types, Hydraulic Motors and its different types, Valves and its different types. Cylinders, Accumulators, Intensifiers, Lifts, Couplings, Torque Converters. Hydraulic Circuit Design and Analysis.

*Pneumatic Actuators*: Compressors, fluid conditioners, Pneumatic cylinders, Valves and Plugs, Basic Pneumatic Circuit Design & Analysis, Accumulator system Analysis.

*Translational mechanics*: circuit analogies, transducers and energy harvesting.

## Minimum Academic Standards

Microelectronics lab.

# BUK-EEE 401 Control Engineering, (3 Units; Core; L = 30; P = 45)

## Senate-approved relevance

Training of high-quality graduates who are highly knowledgeable in control engineering. This will equip the students with the requisite skills for design of control systems. This is in agreement with BUK’s mission to be forefront in digital world and lead Africa in current technologies.

## Overview

A control engineering course typically covers the principles, techniques, and applications of control systems, which are used to regulate and manipulate the behaviour of systems to achieve desired performance and stability. Control engineering is a multidisciplinary field that finds applications in various industries, including manufacturing, robotics, aerospace, automotive, and energy systems.

A course on control engineering provides students with a solid understanding of the principles, methods, and applications of control systems, and equips them with the skills to design and implement control systems in various industries and applications.

## Objectives

In this course students will learn:

1. To provide students with an understanding of the principles and applications of control systems
2. To introduce students to modelling and analysis techniques for control systems
3. To familiarize students with control system design techniques and different types of controllers
4. To develop students' ability to apply control theory to practical engineering problems
5. To prepare students for careers in engineering and related fields.

## Learning Outcomes

On the successful completion of this course, the student should be able to:

1. Understand the principles and applications of control systems
2. Analyze control systems using mathematical models
3. Design control systems using different techniques and types of controllers
4. Apply control theory to practical engineering problems
5. Demonstrate an understanding of advanced control techniques such as state-space control.

## Course Contents

Introduction to Control Systems: Overview of control system components, feedback, and open/closed loop systems.

Mathematical Modeling of Control Systems: Differential equations, Laplace transforms, and transfer functions for modeling control systems.

Control System Analysis: Stability analysis, root locus, Bode plots, and Nyquist plots.

Control System Design: Design of PID controllers, pole placement, and frequency domain design techniques.

State-Space Control: State-space representation, state feedback, and observer design.

Digital Control Systems: Discrete-time systems, z-transforms, and digital control design.

Nonlinear Control Systems: Feedback linearization, sliding mode control, and adaptive control.

Applications of Control Systems: Control of mechanical, electrical, and electromechanical systems.

## Minimum Academic Standards

Control engineering Lab with high performance PC.

# BUK-EEE 402 Power Electronics, (3 Units; Core; L = 30; P = 45)

## Senate-approved relevance

Training of high-quality graduates who are highly knowledgeable in power electronics engineering. This will equip the students with the requisite skills for design of power electronics systems. This is in agreement with BUK’s mission to be forefront in digital world and lead Africa in current technologies.

## Overview

power electronics course typically covers the principles, techniques, and applications of electronic devices and circuits for efficient control and conversion of electrical power. Power electronics is a specialized field of electrical engineering that finds applications in various industries, including renewable energy systems, electric vehicles, industrial automation, and power distribution systems.

This course covers topics such as power semiconductor devices, converter topologies, and control techniques for power electronics. Students will also learn about practical applications of power electronics in renewable energy systems, electric vehicles, and power systems.

## Objectives

In this course students will learn:

1. To provide students with an understanding of the principles and applications of power electronics
2. To introduce students to power semiconductor devices and their characteristics
3. To familiarize students with converter topologies and control techniques for power electronics
4. To develop students' ability to analyze and design power electronic circuits and systems
5. To prepare students for careers in engineering and related fields.

## Learning Outcomes

On the successful completion of this course, the student should be able to:

1. Understand the principles and applications of power electronics
2. Analyze power semiconductor devices and their characteristics
3. Design converter topologies and control techniques for power electronics
4. Analyze and design power electronic circuits and systems
5. Apply the principles of power electronics to solve real-world problems in renewable energy systems, electric vehicles, and power systems.

## Course Contents

Introduction to Power Electronics: Overview of power electronics, applications, and power electronic devices.

Power Semiconductor Devices: Characteristics, operation, and modeling of diodes, thyristors, MOSFETs, and IGBTs.

Converter Topologies: DC-DC converters, AC-DC converters, and DC-AC inverters.

Control Techniques: Pulse width modulation (PWM), hysteresis control, and feedback control.

Applications of Power Electronics: Renewable energy systems, electric vehicles, and power systems.

Design and Analysis of Power Electronic Circuits: Circuit analysis, simulation, and design techniques.

Advanced Topics: Multi-level converters, resonant converters, and power factor correction.

## Minimum Academic Standards

Control engineering Lab with high performance PC.

# BUK-EEE 403 Artificial Intelligence and Applications, (2 Units; Core; L = 30; P = 30)

## Senate-approved relevance

Training of high-quality graduates who are highly knowledgeable in artificial intelligence. This will equip the students with the skills needed for design and developing different application with AI. This is in agreement with BUK’s mission to be forefront in digital world and lead Africa in current technologies.

## Overview

An artificial intelligence (AI) course typically covers the theory, techniques, and applications of AI, which is a multidisciplinary field that encompasses machine learning, deep learning, natural language processing, computer vision, robotics, and other areas. AI is revolutionizing many industries, including healthcare, finance, transportation, and technology, and has the potential to transform society in various ways.

The course covers topics such as machine learning, natural language processing, computer vision, and robotics. Students will also learn about practical applications of AI in areas such as healthcare, finance, and transportation. The course provides students with a solid understanding of the theory, techniques, and applications of AI, and equips them with the skills to design, implement, and deploy AI systems for various industries and applications. It enables students to contribute to the development of cutting-edge AI technologies and applications, and to address real-world challenges using AI approaches.

## Objectives

In this course:

1. To provide an understanding of the fundamental concepts and techniques of artificial intelligence
2. To introduce students to various AI applications in different domains
3. To develop skills in machine learning, natural language processing, computer vision, and robotics
4. To prepare students for careers in AI and related fields.

## Learning Outcomes

On the successful completion of this course, the student should be able to:

1. Understand the fundamental concepts and techniques of artificial intelligence
2. Apply machine learning algorithms to real-world problems
3. Develop natural language processing systems for text analysis and generation
4. Build computer vision systems for image and video processing
5. Design and implement robotics systems for automation and control
6. Analyze and evaluate the performance of AI systems
7. Apply the principles of AI to solve real-world problems in healthcare, finance, and transportation.

## Course Contents

Introduction to Artificial Intelligence: Overview of AI, history, and applications.

Machine Learning: Supervised and unsupervised learning, decision trees, neural networks, and deep learning.

Natural Language Processing: Text processing, sentiment analysis, and chatbots.

AI in Robotics: Robot kinematics, dynamics, and control.

AI Applications: Healthcare, finance, transportation, and other domains.

AI Ethics: Ethical and social issues related to AI development and deployment.

## Minimum Academic Standards

Computer Lab with high performance PC.

# BUK-EEE 404 Integrated Systems Design Project, (3 Units; Core; L = 30; P = 45)

## Senate-approved relevance

Training of high-quality graduates who are highly skilled in implementation of integrated power system scheme. This will equip the students with the skills needed for design and developing mini power grid networks. This is in agreement with BUK’s mission to be forefront in digital world and lead Africa in current technologies.

## Overview

A project is assigned to challenge the students for design, simulation and/or practical implementation of integrated power system scheme. Such project could be infrastructure design proposal to reduce the university’s carbon footprint. The design proposal is intended to transport renewable energy generated from a nearby Solar PV facility to the campus/off campus or any other project prescribed by Power Systems research group.

## Objectives

In this course:

1. Students will design a micro-grid system
2. Construction of power systems components
3. Practically manage a mini project

## Learning Outcomes

On the successful completion of this course, the student should be able to:

1. Work as a team.
2. To manage a project. (Project Management and Project Definition).
3. Present report via power point presentation techniques.
4. Produce a well-documented engineering report.
5. Design a micro-grid system, construction of power systems components, developing mini solar power systems.

## Course Contents

There will be numbers of class room lectures (within 3-5 weeks) on cost analysis, reliability of systems and how to make good power point slides and technical report. Guidance by supervisor and lab technologist. Group presentation and technical report and student participation will comprise the 100% assessment of the course

## Minimum Academic Standards

# BUK-EEE 405 AC Machines, (3 Units; Core; L = 30; P = 45)

## Senate-approved relevance

Training of high-quality graduates who are highly skilled AC machines design. This will equip the students with the skills needed for design and developing AC machines. This is in agreement with BUK’s mission to be forefront in digital world and lead Africa in current technologies.

## Overview

Understand the principles and characteristics of AC machines. This course is about electromechanics and uses electric machinery as examples. Students will have an understanding of the principles of the energy conversion parts of mechatronics. In addition to design, students will also learn how to estimate the dynamic parameters of electric machines and understand what the implications of those parameters are on performance of systems incorporating those machines.

## Objectives

In this course:

1. Students can synchronize of 3-phase alternators
2. Determine of short circuit characteristics of a synchronous machine

## Learning Outcomes

On the successful completion of this course, the student should be able to:

1. Know the concept of operation AC machines such as induction machine.
2. Understand the different types of synchronous machine and their operations.
3. Determine the characteristics of AC machine.
4. Determine machine parameters using different experimentation methods.
5. Know the methods use in the control of AC machines.

## Course Contents

*Polyphase Induction Machine:* Determination of circuit model parameters. Phasor diagram. Circuit diagram. Motor performance in the steady-state. Power factor adjustment. Brief discussion of the effect of harmonics (cogging, crawling, noise and additional loss). Unbalanced operation. Induction generators.

*Single-phase induction Motors:* Circuit model of single-phase induction motors. Performance calculation and characteristics: split phase motor, capacitor start motor, permanent capacitor motor, shaded-pole motor, universal motor, repulsion motor and linear motor.

*Synchronous Machines:* Operation of salient pole machine. Synchronous machine on infinite bus bar (cylindrical and salient poles types). Paralleling of polyphase synchronous machines (synchronization). Parallel operation of generators. Open-circuit and short-circuit characteristics. Measurement of synchronous reactance. Short-circuit ratio. Calculating excitation requirements for given operating point conditions. Potier triangle method of measuring leakage reactance. The capability curves. Voltage regulation of generators.

*AC Machine control:* Starting and breaking speed control. Faults and protection.

## Minimum Academic Standards

AC Machine laboratory with 3-phase power supply

# BUK-EEE 501 Analog Electronics Laboratory, (3 Units; Core; L = 30; P = 45)

## Senate-approved relevance

Training of high-quality graduates who are highly skilled Analog Electronics. This will equip the students with the skills needed for designing and implementing circuits for use in the industries. This is in agreement with BUK’s mission to be forefront in producing graduate that are ready for the industries.

## Overview

An Analog Electronics Laboratory course provides students with practical skills in designing, building, and testing analog electronic circuits, and reinforces the theoretical concepts learned in analog electronics courses. It helps students develop hands-on experience in working with electronic components, laboratory equipment, and circuit design, and enhances their ability to analyze, troubleshoot, and report on experimental results. This course prepares students for careers in analog electronics design, testing, and research, and provides a solid foundation for further advanced courses in electronics and electrical engineering.

This course explores the design, construction, and debugging of analog electronic circuits. The course deals with the performance characteristics of semiconductor devices (diodes, BJTs, and MOSFETs) and advance functional analog building blocks, including single-stage amplifiers, op amps, small audio amplifier, filters (higher orders), converters, sensor circuits, and medical electronics (ECG, pulse-oximetry). Projects involve design, implementation, and presentation in an environment similar to that of industry engineering design teams.

## Objectives

In this course:

1. To understand fundamental electronic circuits for engineering applications.
2. To gain ability of analysing and designing electronic circuits.
3. To gain practical skills by building and testing electronic circuits in lab, using real electronic components

## Learning Outcomes

On the successful completion of this course, the student should be able to:

1. Analyze common analogue circuit diagrams to identify and interpret circuit behaviors in time and frequency domains.
2. Produce circuit designs for a given specification and Select component types and values in common circuit configurations.
3. Model circuit using simulation software packages
4. Apply analytical approaches to simple linear and non-linear circuits
5. Assembly electronic circuits using real components
6. Test electronic circuits on bread-board and analyze the measurement results from the circuits.

## Course Contents

*Components:* Resistors and capacitors standard values, Component symbols, Frequency response, bode plots, basics review*.*

*Diodes:* Diodes, diode equation, Graphical/Load line analysis, Diode models- Ideal, Piecewise linear, AC, Other diode types, Zener diodes, Diode applications- Peak sample, power rectifier, clamps, regulator

*Bipolar transistors:* Definitions, V-I characteristics, breakdown, Common-emitter large signal model, graphical analysis, Common-collector, Common-emitter, Applications: current source, DC power supply regulator, Bipolar transistors, Transistor biasing, Hybrid-pi equivalent circuit, High-frequency hybrid-pi, H-parameters, Common-emitter amplifier, AC load line, Common-collector (emitter-follower) amplifier, Junction field-effect transistors*.*

*Operational amplifiers:* Overview, Basic linear op-amp circuits, Inverting, non-inverting, addition, subtraction, amplifiers, inverting, and non-inverting, Cascading; Ideal impedances, I-V conv, V-I conv, difference amp, instrument amp, Integrator, differentiator, Lossy integrator, Negative feedback

*Operational amplifiers:* Limitations, Effect of finite open-loop gain, Differential and common mode input voltage limits, Common-mode rejection ration, Input resistance, Input bias current, input offset current, Non-zero output resistance, Frequency response, gain-bandwidth product, Output voltage swing, saturation, Output current limit, Compensation, Slew rate, Offset voltage and drift, Op-amp selection considerations, Non-linear op-amp circuits, Precision ½ wave rectifier, log and antilog amps, Comparator, Schmitt-trigger, Schmitt-trigger oscillator [astable multivibrator], 555 IC timer.

## Minimum Academic Standards

Electronics laboratory

# BUK-EEE 502 Power Electronics Laboratory, (3 Units; Core; L = 30; P = 45)

## Senate-approved relevance

Training of high-quality graduates who are highly skilled Power Electronics. This will equip the students with the skills needed for designing and implementing circuits for use in the power electronics industries. This is in agreement with BUK’s mission to be forefront in producing graduate that are ready for the industries.

## Overview

A Power Electronics Laboratory course typically provides hands-on experience in designing, building, and testing power electronic circuits in a laboratory setting. The course is typically taken as part of an electrical engineering or power electronics curriculum and complements theoretical concepts learned in power electronics courses.

The course also provides students with practical skills in designing, building, and testing power electronic circuits, and reinforces the theoretical concepts learned in power electronics courses. It helps students develop hands-on experience in working with power electronic devices, simulation tools, and laboratory equipment, and enhances their ability to analyze, troubleshoot, and report on experimental results. This course prepares students for careers in power electronics design, testing, and research, and provides a solid foundation for further advanced courses in power electronics and electrical engineering. Introduces the design and construction of power electronic circuits and motor drives. Devices include the construction of drive circuitry for an electric go-cart, computer power supplies, three-phase inverters for AC motors, intelligent bulk and boost converters. Basic electric machines introduced include DC, induction, and permanent magnet motors, with drive considerations.

## Objectives

In this course:

1. To understand power electronic circuits for engineering applications.
2. To gain ability of analysing and designing power electronic circuits.
3. To gain practical skills by building and testing power electronic circuits in lab, using real power electronic components

## Learning Outcomes

On the successful completion of this course, the student should be able to:

1. Analyze the 3 classes of DC/DC converter; calculate stresses on components; sketch circuit diagrams and waveforms; determine conduction modes; select circuit parameters.
2. Sketch and explain diagrams and idealized waveforms for uncontrolled diode rectifiers with source inductance and for inverters as active rectifiers.
3. Calculate steady-state thermal values and losses, to determine operating points and ratings of power electronic components.
4. Evaluate strategies for voltage synthesis (Pulse Width Modulation) and current control, and calculate parameters for single- and three- phase inverters.
5. Examine laboratory measurements and simulation results on power converter circuits, interpret waveforms and apply to tune the control loop.

## Course Contents

Devices include the construction of drive circuitry for an electric go-cart, computer power supplies, three-phase inverters for AC motors, intelligent bulk and boost converters. Basic electric machines introduced include DC, induction, and permanent magnet motors, with drive considerations.

## Minimum Academic Standards

Power Electronics laboratory

# BUK-EEE 503 Electric Drives, (2 Units; Core; L = 30; P = 30)

## Senate-approved relevance

Training of high-quality graduates who are highly skilled in electric drives. This will equip the students with the skills needed to convert electrical to mechanical energy and control as applied in industries. This is in agreement with BUK’s mission to be forefront in producing graduate that are ready for the industries.

## Overview

An electric drives course provides students with a comprehensive understanding of the theory, design, and practical implementation of electric drive systems. It equips students with the knowledge and skills necessary to analyze, design, and optimize electric drives for various applications, and prepares them for careers in industries related to electric drives, such as automotive, manufacturing, energy, and transportation.

Introduce the methods by which electrical energy is converted from one voltage level to another using transformers or solid-state techniques, and converted to mechanical energy, using electrical machines and appropriate control techniques.

## Objectives

In this course:

1. To understand electrical drives for engineering applications.
2. To gain ability of analysing and designing electrical drives.
3. To gain practical skills by building and testing electrical drives.

## Learning Outcomes

On the successful completion of this course, the student should be able to:

1. Describe with the aid of sketched waveforms the operation of DC-DC converters and single-phase rectifiers.
2. Formulate the equivalent circuit representations of transformers, induction, synchronous and BLDC machines.
3. Model the behaviour of transformers and machines using the per-phase equivalent circuits.
4. Analyse the waveforms of DC-DC and AC-DC converters, and calculate operating conditions, component values and switching losses.
5. Evaluate the technical and environmental impact of electrical drive and power electronic technologies.

## Course Contents

Basis of machine speed control. Nominal speed range and smoothness of speed control. Stability of operation and economic justification. *Speed control of DC Machines:* Braking of DC motor. Shunt field rheostat control. Armature circuit resistance control. Armature terminal voltage control. The Ward-Leonard system. *Thyristors DC Machines Control:* Control of DC motors using thyristors three phase types. DC-DC or chopper control of DC motors. Microprocessor control. *Control of induction Motors:* pole-changing method, pole amplitude modulation. Controlling speed by frequency, line voltage control. *Control of Synchronous Machines:* Starting methods. *Thyristors AC machines Control:* Variable frequency AC motor drive systems. Control with DC-Link converters. Flip power recovery. Variable frequency synchronous motor drives.

## Minimum Academic Standards

Power Electronics laboratory