**Bayero University, Kano (BUK)**

**Faculty of Engineering**

# Department Electrical Engineering

# B. Eng. Computer

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

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

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| **LEVEL 200** | | | | | |
| **CODE** | **COURSE NAME** | **Unit** | **Status** | **LH** | **PH** |
| BUK-CPE 201 | Introduction to Signal Processing | 3 | C | 30 | 45 |
| BUK-CPE 202 | Introduction to Machine Learning | 3 | C | 30 | 45 |
|  | **Total** | **6** |  |  |  |

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| **LEVEL 300** | | | | | |
| **CODE** | **COURSE NAME** | **Unit** | **Status** | **LH** | **PH** |
| BUK-CPE 301 | System Modelling and Analysis | 3 | C | 30 | 45 |
| BUK-CPE 302 | Digital Electronics | 2 | C | 30 | 15 |
| BUK-CPE 303 | Communications Principles | 2 | C | 30 | 15 |
| BUK-CPE 304 | Measurement and Instrumentation | 2 | C | 30 | 15 |
| BUK-CPE 305 | Analogue Circuits and Electronics | 4 | C | 45 | 45 |
| BUK-CPE 306 | Sensors and Actuators | 2 | C | 30 | 15 |
| BUK-CPE 307 | Database Programming | 3 | C | 30 | 45 |
| BUK-CPE 308 | Introduction to Image Processing | 3 | C | 30 | 45 |
|  | **Total** | **21** |  |  |  |

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| --- | --- | --- | --- | --- | --- |
| **LEVEL 400** | | | | | |
| **CODE** | **COURSE NAME** | **Unit** | **Status** | **LH** | **PH** |
| BUK-CPE 401 | Introduction to Digital Communications | 2 | C | 30 | 15 |
|  | **Total** | **2** |  |  |  |

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| **LEVEL 500** | | | | | |
| **CODE** | **COURSE NAME** | **Unit** | **Status** | **LH** | **PH** |
| BUK-CPE 501 | Digital Systems Design | 3 | C | 30 | 45 |
| BUK-CPE 502 | Introduction to Computer Vision | 2 | C | 30 | 15 |
| BUK-CPE 503 | Nanoelectronics and Computing Systems | 3 | C | 30 | 45 |
| BUK-CPE 504 | Cryptography & Crypto Analysis | 2 | C | 30 | 15 |
|  | Elective | 3 | C | 30 | 45 |
|  | **Total** | **13** |  |  |  |
|  | **Grand Total** | **50** |  |  |  |

# BUK-CPE 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 1and 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 analyzing 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-CPE 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-CPE 202 Introduction to Machine Learning, (3 Units; Core; L = 30; P = 45)

## Senate-approved relevance

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

## Overview

Introduction to Machine Learning is a course that provides an overview of the fundamental concepts and techniques of machine learning. The course covers topics such as data preparation, model selection, and evaluation, as well as practical applications of machine learning in various fields.

Students will also gain hands-on experience with popular machine learning libraries and frameworks.

## Objectives

In this course students will learn:

1. To provide an understanding of the fundamental concepts and techniques of machine learning
2. To introduce students to various types of machine learning models and algorithms
3. To develop skills in data preparation, model selection, and evaluation
4. To prepare students for careers in data science 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 machine learning
2. Identify appropriate machine learning models and algorithms for different types of problems
3. Prepare data for machine learning applications
4. Evaluate machine learning models and interpret the results
5. Apply machine learning to solve real-world problems in various fields.

## Course Contents

Introduction to Machine Learning: Overview of machine learning, history, and applications.

Data Preparation: Data cleaning, feature selection, and feature engineering.

Supervised Learning: Regression, classification, decision trees, and ensemble methods.

Unsupervised Learning: Clustering, dimensionality reduction, and anomaly detection.

Model Selection and Evaluation: Cross-validation, bias-variance trade-off, and performance metrics.

## Minimum Academic Standards

Computer Lab with high performance PC

# BUK-CPE 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-CPE 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-CPE 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-CPE 304 Measurement and Instrumentation, (3 Units; Core; L = 30; P = 45)

## 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 understanding different sensors working principle with different applications. This is in agreement with BUK’s mission to be forefront in digital world and lead Africa in current technologies.

## Overview

Measurement and Instrumentation focuses on the principles, techniques, and practices of measuring physical quantities and using instruments to obtain accurate and reliable measurements. This course is typically offered in engineering and science-related disciplines and provides students with knowledge and skills in measurement theory, instrumentation, and data analysis.

The course is critical for engineers, scientists, and researchers involved in the design, implementation, and analysis of measurement systems in various fields, including engineering, physics, chemistry, environmental science, and biotechnology. It provides students with the knowledge and skills necessary for accurate and reliable measurement, data acquisition, and data analysis, which are essential for many areas of modern science and engineering.

## Objectives

In this course students will learn:

1. To provide an understanding of the principles and techniques of measurement and instrumentation
2. To introduce students to various types of sensors and transducers and their applications
3. To develop skills in signal conditioning, data acquisition, and measurement uncertainty analysis
4. To prepare students for careers in measurement and instrumentation and related fields.

## Learning Outcomes

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

1. Understand the principles and techniques of measurement and instrumentation
2. Identify appropriate sensors and transducers for different types of measurements
3. Apply signal conditioning and data acquisition techniques to measure physical quantities
4. Analyze and evaluate the uncertainty of measurement results
5. Apply measurement and instrumentation techniques to solve real-world problems in various fields.

## Course Contents

Introduction to Measurement and Instrumentation: Overview of measurement and instrumentation, history, and applications.

Sensors and Transducers: Types of sensors and transducers, principles of operation, and applications.

Signal Conditioning: Amplification, filtering, and noise reduction techniques.

Data Acquisition: Analog-to-digital conversion, sampling, and data storage.

Measurement Uncertainty: Sources of uncertainty, error analysis, and uncertainty evaluation.

Instrumentation Systems: Measurement systems and instruments, calibration, and traceability.

Applications of Measurement and Instrumentation: Healthcare, manufacturing, energy, and other fields.

## Minimum Academic Standards

Instrumentation Lab with high performance PC

# BUK-CPE 305 Analogue Circuits and Electronics, (4 Units; Core; L = 45; P = 45)

## Senate-approved relevance

Training of high-quality graduates who are highly knowledgeable in analog circuits. This will equip the students with the skills needed for understanding analog electronics principles. This is in agreement with BUK’s mission to be forefront in digital world and lead Africa in current technologies.

## Overview

Analog Circuits and Electronics course is typically offered in electrical engineering and related fields, and focuses on the principles, analysis, design, and applications of analog electronic circuits. Analog circuits deal with continuous signals and are widely used in various electronic systems, such as amplifiers, filters, oscillators, and power supplies. This course provides students with the fundamental knowledge and skills necessary to understand, analyze, and design analog electronic circuits.

Students will be exposed to practical applications of analog circuits and electronics, such as audio amplifiers, RF circuits, sensor interfaces, and instrumentation systems. They may also have opportunities for hands-on lab experiments, circuit prototyping, and testing using actual electronic components and instruments.

## Objectives

In this course students will learn:

1. To provide an understanding of the principles and techniques of analog circuit design and electronics
2. To introduce students to various types of electronic devices and circuits and their applications
3. To develop skills in circuit analysis, design, and prototyping
4. To prepare students for careers in electronics engineering and related fields.

## Learning Outcomes

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

1. Understand the principles and techniques of analog circuit design and electronics
2. Identify appropriate electronic devices and circuits for different types of applications
3. Analyze and design analog circuits and systems
4. Prototype and test electronic circuits and systems
5. Apply analog circuit design and electronics techniques to solve real-world problems in various fields.

## Course Contents

Introduction to Analog Circuits and Electronics: Overview of analog circuits and electronics, history, and applications.

Basic Electronic Devices: Resistors, capacitors, inductors, diodes, and transistors.

Amplifiers: Operational amplifiers, feedback, and stability analysis.

*Positive feedback*, oscillators, LC networks- homogeneous response, Driven LC networks- inhomogeneous (step) response, RLC homogeneous response, quality factor.

Power Supplies and Boost converter.

*Sinusoidal steady state response SSS*: R-L, R-C, and R-L-C Circuits. Filters, RLC resonators, Tesla coil, Second-order op-amp filters. Realization of electrical circuits: Foster and Cauer’s methods of synthesis.

Nonlinear resistors and large-signal and small signal analysis, Op-amp and nonlinear resistor (diode) combinations: multipliers and peak detectors.

MOSFET, large-signal MOSFET amplifier, Biasing, linearization, small-signal MOSFET amplifier analysis

Filters: Passive and active filters, frequency response, and transfer functions.

## Minimum Academic Standards

Electronics Lab with high performance PC

# BUK-CPE 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-CPE 307 Database Programming, (2 Units; Core; L = 30; P = 30)

## Senate-approved relevance

Training of high-quality graduates who are highly skilled in database programming. This will equip the students with the skills needed for designing and developing database applications via mobile apps and computer desktop. This is in agreement with BUK’s mission to be forefront in digital world and lead Africa in current technologies.

## Overview

To know the principles of database systems and management and development of hands‑on skills using SQL. The course unit is to introduce the students to the fundamental concepts and techniques that underpin modern database management systems (DBMSs).

The course unit studies the motivation for managing data as an asset and introduces the basic architectural principles underlying modern DBMSs.

## Objectives

In this course:

1. Apply SQL for data definition to database.
2. Apply SQL for data manipulation (CRUD) to database.
3. Develop database mobile applications.
4. Develop windows-based database application.

## Learning Outcomes

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

1. Discuss and explain the principles of database design.
2. Apply conceptual design methodologies of DBMS.
3. Apply the relational model, and, in particular the derivation of relational schemas from conceptual designs and the normalisation of those schemas.
4. Design simple database mobile app using open-source software.
5. Design simple database windows app using C#.

## Course Contents

*Database*: Introduction to MIS. Important concepts and terminology associated with relational databases. (Using SQLite database)

*Introduction to SQL*: Data Definition Language, Data Manipulation Language. Create and run SQL commands to create tables, use data types, and add rows to tables. Performing CRUD (Create, Retrieve, Update, Delete) operations.

App Design using Android open source and windows app using C#.

## Minimum Academic Standards

Computer Lab with high performance PC

# BUK-CPE 308 Introduction to Image Processing, (3 Units; Core; L = 30; P = 45)

## Senate-approved relevance

Training of high-quality graduates who are highly skilled in image processing. This will equip the students with the skills needed for using computer program in designing 2D signal processing. This is in agreement with BUK’s mission to be forefront in digital world and lead Africa in current technologies.

## Overview

Introduction to Image Processing is a field of study that deals with the analysis, processing, and manipulation of digital images. The course introduces students to the fundamental concepts and techniques used in image processing, such as image enhancement, image restoration, and image segmentation. The course typically includes lectures, lab sessions, and project work to provide hands-on experience in processing and analysing digital images.

The course aims to provide students with a solid foundation in the principles and techniques of image processing, enabling them to develop and implement image processing algorithms for various applications.

## Objectives

The objectives of this course are:

1. Understanding the fundamental concepts and principles of digital image processing.
2. Understanding the various techniques used in image processing, such as image enhancement, image restoration, and image segmentation.
3. Understanding the basics of image acquisition, image representation, and color models.
4. Understanding the limitations and challenges of digital image processing.
5. Developing skills to implement and analyze image processing algorithms using software tools.
6. Understanding the application of image processing techniques in various fields, such as medical imaging, remote sensing, and computer vision.
7. Developing skills to analyze, interpret, and communicate results of image processing algorithms.

## Learning Outcomes

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

1. Implement and analyze image processing algorithms using software tools.
2. apply of image processing techniques in various fields, such as medical imaging, remote sensing, and computer vision.
3. analyze, interpret, and communicate results of image processing algorithms.

## Course Contents

Introduction to Digital Image Processing: Overview of digital images, image acquisition, and the basics of image processing.

Image Enhancement: Techniques to improve the visual appearance of an image, such as contrast stretching, histogram equalization, and spatial filtering.

Image Restoration: Techniques to remove noise and other artifacts from images, such as median filtering, Wiener filtering, and deconvolution.

Image Segmentation: Techniques to separate an image into different regions or objects, such as thresholding, region growing, and edge detection.

Image Analysis: Techniques to extract useful information from images, such as feature extraction, object recognition, and pattern recognition.

Applications of Image Processing: Examples of image processing applications in various fields, such as medical imaging, remote sensing, and computer vision.

## Minimum Academic Standards

Computer Lab with high performance PC

# BUK-CPE 401 Introduction to Digital Communications, (3 Units; Core; L = 30; P = 45)

## Senate-approved relevance

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

## Overview

Introduction to Digital Communications is a course that is typically offered in electrical engineering, telecommunications, or related fields. It focuses on the fundamental concepts and techniques used in digital communications, which involve the transmission and reception of information over digital channels. Digital communications play a crucial role in modern communication systems, such as wireless and wired networks, satellite communication, and data storage and retrieval.

This course provides students with a solid foundation in the principles, technologies, and applications of digital communications.

## Objectives

The objectives of this course are:

1. To provide an understanding of the principles and techniques of digital communication systems.
2. To introduce students to various types of digital modulation techniques and their applications.
3. To develop skills in channel coding, signal detection, and estimation.
4. To prepare students for careers in digital communications and related fields.

## Learning Outcomes

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

1. Understand the principles and techniques of digital communication systems.
2. Identify appropriate digital modulation techniques for different types of applications.
3. Analyze and design digital communication systems.
4. Evaluate the performance of digital communication systems.
5. Apply digital communication techniques to solve real-world problems in various fields.

## Course Contents

Introduction to Digital Communications: Overview of digital communication systems, history, and applications.

Digital Modulation Techniques: Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK), and Quadrature Amplitude Modulation (QAM).

Channel Coding: Block codes, convolutional codes, and Turbo codes.

Signal Detection and Estimation: Optimum receiver, matched filter, and decision-making.

Error Analysis: Bit Error Rate (BER), Symbol Error Rate (SER), and Signal-to-Noise Ratio (SNR).

Applications of Digital Communications: Telecommunications, wireless communication, and other fields.

## Minimum Academic Standards

Digital communications Lab with high performance PC

# BUK-CPE 501 Digital Systems Design, (3 Units; Core; L = 30; P = 15)

## Senate-approved relevance

Training of high-quality graduates who are highly skilled in designing digital circuits using FPGA. This is the current trends in medical, security and autonomous robots in the world. This will equip the students with the skills needed for using computer program in designing applications using FPGA. This is in agreement with BUK’s mission to be forefront in digital world and lead Africa in current technologies.

## Overview

Digital Systems Design is a course that is typically offered in electrical engineering, computer engineering, or related fields. It focuses on the principles, techniques, and tools used in designing digital systems, which are the foundation of modern electronic devices and computer systems. Digital systems are composed of digital logic circuits that perform operations on digital signals to process information and perform tasks.

This course provides students with a comprehensive understanding of the fundamentals of digital systems design, including digital logic design, hardware description languages, and synthesis and implementation of digital systems.

## Objectives

In this course, the objectives are:

1. To provide an understanding of digital systems and their components.
2. To develop skills in designing and implementing digital circuits and systems.
3. To introduce students to hardware description languages such as VHDL and Verilog.
4. To prepare students for careers in digital systems design and related fields.

## Learning Outcomes

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

1. Understand digital systems and their components.
2. Design and implement digital circuits and systems.
3. Use hardware description languages to describe and simulate digital systems.
4. Analyze and optimize digital systems for performance and power consumption.
5. Apply digital systems design techniques to solve real-world problems.

## Course Contents

Introduction to Digital Systems: Overview of digital systems, number systems, and Boolean algebra.

Combinational Circuits: Design of combinational circuits, adders, subtractors, multiplexers, and demultiplexers.

Sequential Circuits: Design of sequential circuits, flip-flops, registers, counters, and memory.

Finite-State Machines: Design and analysis of finite-state machines, state minimization, and state assignment.

Hardware Description Languages: Overview of VHDL and Verilog, design and simulation of digital systems.

Digital System Optimization: Timing analysis, power optimization, and testing.

## Minimum Academic Standards

FPGA Lab with high performance PC

# BUK-CPE 502 Introduction to Computer Vision, (2 Units; Core; L = 30; P = 15)

## Senate-approved relevance

Training of high-quality graduates who are highly skilled in using computer for advance image processing using machine learning. This is the current trends in medical, security and autonomous robots in the world. This will equip the students with the skills needed for using computer program in designing computer vision applications. This is in agreement with BUK’s mission to be forefront in digital world and lead Africa in current technologies.

## Overview

The tools and algorithms of computer vision are introduced in the context of two major capabilities required of visual systems: recognition - finding and identifying expected things in images and 3D interpretation - understanding a dynamic 3D scene from 2D images or sequences of images. These capabilities are explored using applications of varying levels of complexity: recognising man-made objects, interpreting medical images, face recognition, robotics, scene reconstruction and surveillance.

The course may include lectures, discussions, and hands-on programming assignments using popular computer vision software libraries such as OpenCV, MATLAB, and Python. Students may be required to complete a final project that involves applying computer vision techniques to a real-world problem

## Objectives

In this course, the objectives are:

1. To provide a broad introduction to Computer Vision and Image Interpretation.
2. To introduce the basic concepts and algorithmic tools of Computer Vision.
3. To explore the importance of modelling and representation in interpretation of images.
4. To provide an understanding of the range of processing components involved in image interpretation systems.

## Learning Outcomes

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

1. Describe image segmentation as a clustering problem and be able to compare different clustering algorithms for segmenting images
2. Describe interest points and local feature in images, compare the strengths and weaknesses of different local features and apply them to solve object recognition, image retrieval and stereo-based scene reconstruction problems.
3. design and compare model-based object recognition algorithms and analyse the strengths and weaknesses of model-based vs image-based object recognition computer vision systems.
4. apply the basic steps of stereopsis, analyse the differences between sparse and dense stereo vision matching algorithms and apply them to solve stereo-based scene reconstruction problems.
5. apply the basic steps of rigid and non-rigid image registration algorithms and analyse their use to biomedical image applications

## Course Contents

Introduction to computer vision: definition, applications, and history

Image acquisition and pre-processing: camera models, image formation, color spaces, noise removal, and image filtering

Image segmentation: thresholding, edge detection, region-based methods, and contour analysis

Feature extraction and description: point features, local descriptors, texture analysis, and shape analysis

Object recognition and detection: template matching, classification, and object detection using machine learning algorithms

Camera calibration and 3D reconstruction: intrinsic and extrinsic parameters, stereo vision, and structure from motion

Motion analysis: optical flow, tracking, and activity recognition

Deep learning for computer vision: convolutional neural networks (CNNs), transfer learning, and object detection using state-of-the-art models such as YOLO and Mask R-CNN

Applications of computer vision: face recognition, medical imaging, surveillance, robotics, and autonomous vehicles.

## Minimum Academic Standards

Computer Lab with high performance PC

# BUK-CPE 503 Nanoelectronics and Computing Systems, (3 Units; Core; L = 30; P = 45)

## Senate-approved relevance

Training of high-quality graduates who are highly skilled in IC fabrication. This will equip the students with the skills needed for designing microelectronic circuits using semiconductor physics principle. This is in agreement with BUK’s mission to be forefront in digital world and lead Africa in current technologies.

## Overview

This course is an introductory to semiconductor physics to modern state-of-the-art nano-scale devices. Student learn interaction between materials, semiconductor physics, electronic devices, and computing systems. Topics include basic processing techniques, such as diffusion, oxidation, epitaxy, photolithography, chemical vapor deposition, physical vapor deposition, plasma etching, and metallization.

At the end of this course, one should have a good understanding of the various processing techniques used to fabricate integrated circuits and micro/nanostructures.

## Objectives

In this course students will learn to do the following:

1. Semiconductor physics: Explain and apply basic concepts of semiconductor Physics relevant to devices.
2. Semiconductor devices: Describe, explain, and analyze the operation of important semiconductor devices In terms of their physical structure
3. Physics-­‐based models: Explain, describe, and use physics-­‐based device and circuit models for semiconductor devices of varying levels of complexity, select models appropriate to a specific need, and apply those models to analyze multi-­‐component circuits
4. Circuit analysis: Analyze and design microelectronic circuits for linear amplifier and digital applications
5. Design: Confront integrated device and/or circuit design problems, identify the design issues, and develop solutions

## Learning Outcomes

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

1. Explain and apply the semiconductor concepts of drift, diffusion, donors and acceptors, majority and minority carriers, excess carriers, low level injection, minority carrier lifetime, quasi-neutrality, and quasi-statics.
2. Explain and apply the semiconductor concepts of drift, diffusion, donors and acceptors, majority and minority carriers, excess carriers, low level injection, minority carrier lifetime, quasi-­‐ neutrality, and quasi-­‐statics;
3. create an incremental (small signal) linear equivalent circuit (LEC) model for a multi-terminal nonlinear electronic device knowing its large signal characteristics;
4. explain how devices and integrated circuits are fabricated and describe discuss modern trends in the microelectronics industry;
5. use large signal and incremental LEC device models to analyze analog electronic circuits of moderate complexity, including circuits with multiple stages, nonlinear and active loads, and current source bias circuits;
6. determine the frequency range of simple electronic circuits and understand the high frequency limitations of BJTs and MOSFETs;
7. explain the operation and features of common MOS logic inverter stages;
8. calculate the transfer characteristics of a CMOS inverter and explain how device dimensions and parameters impact them and inverter switching speed;
9. design simple devices and circuits to meet stated operating specifications.

## Course Contents

Modelling of microelectronic devices, basic microelectronic circuit analysis and design, physical electronics of semiconductor junction and MOS devices, relation of electrical behaviour to internal physical processes, development of circuit models, and understanding the uses and limitations of various models. The course uses incremental and large-signal techniques to analyze and design bipolar and field effect transistor circuits, with examples chosen from digital circuits, single-ended and differential linear amplifiers, and other integrated circuits.

## Minimum Academic Standards

Computer Lab with high performance PC

# BUK-CPE 504 Cryptography & Crypto Analysis, (2 Units; Core; L = 30; P = 15)

## Senate-approved relevance

Training of high-quality graduates who are highly skilled in computer and network security. Due to high cyber-attack around the world, this is one of the important trending courses around the globe. This will equip the students with the skills needed for designing computer network security in devices and communications. This is in agreement with BUK’s mission to be forefront in digital world and lead Africa in current technologies.

## Overview

This is an introductory course that focuses on fundamental cryptographic principles, including public-key encryption, digital signatures, classical ciphers, data encryption standards, information theory and unbreakable one-time pad, cryptographic protocols, privacy, authentication, key distribution, shared secrets, public key systems, knapsack and exponential ciphers. Applications to computer security.

Students will learn the importance of pseudo-random number generators and their applications in cryptography. Computer security will be treated.

## Objectives

In this course students will learn to do the following:

1. Understand the landscape of cyber security and knowledge and skills to identify and address cyber threats at multiple levels.
2. Exploring security methods, protocols and other techniques to protect data and networked and distributed systems against cyber threats.

## Learning Outcomes

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

1. Analyse, identify and classify vulnerabilities and security threats and attacks in a given setting.
2. Describe and design system security solutions such as those for user identity, access and trust managements.
3. Describe and design network security solutions such as those for protecting networked systems and devices.
4. Describe, design and apply application security solutions such as those for protecting Internet-based services.
5. Analyse, identify and describe software security issues, countermeasures and best practices.

## Course Contents

Introduction to Cybersecurity: Notion of Cybersecurity and domains, security threat analysis and classifications, Cybersecurity framework

Cryptographic Tools and Protocols: Confidentiality with symmetric encryption, message authentication and hash functions, public-key encryption, digital signatures, key management, security protocol design, pseudo-random number generation

Identity and Privilege Management: User identification and authentication, single sign-on, multi-factor authentication, access control mechanisms

 Network and Distributed System Security: Enterprise network security, web security, email security, e-transaction security, Cloud and IoT security

 Software Security: Malicious software, software vulnerabilities and exploitations, countermeasures and best practices.

## Minimum Academic Standards

Computer Lab with high performance PC