**Bayero University, Kano (BUK)**

**Faculty of Engineering**

# Department Electrical Engineering

# B. Eng. Telecommunication

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **LEVEL 100** | | | | | |
| **CODE** | **COURSE NAME** | **Unit** | **Status** | **LH** | **PH** |
| BUK-TEE 103 | Basic Statistics | 3 | C | 45 | - |
|  | **Total** | **3** |  |  |  |

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **LEVEL 300** | | | | | |
| **CODE** | **COURSE NAME** | **Unit** | **Status** | **LH** | **PH** |
| BUK-TEE 301 | System Modelling and Analysis | 3 | C | 30 | 45 |
| BUK-TEE 302 | Digital Electronics | 2 | C | 30 | 15 |
| BUK-TEE 304 | Measurement and Instrumentation | 2 | C | 30 | 15 |
| BUK-TEE 305 | Analogue Circuits and Electronics | 4 | C | 30 | 45 |
| BUK-TEE 306 | Sensors and Actuators | 2 | C | 30 | 15 |
| BUK-TEE 308 | Introduction to Image Processing | 3 | C | 30 | 45 |
|  | **Total** | **16** |  |  |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **LEVEL 400** | | | | | |
| **CODE** | **COURSE NAME** | **Unit** | **Status** | **LH** | **PH** |
| BUK-TEE 401 | Introduction to Digital Communications | 2 | C | 30 | 15 |
| BUK-TEE 402 | Wireless Sensor Networks | 3 | C | 30 | 45 |
| BUK-TEE 403 | Artificial Intelligence and Applications | 3 | C | 30 | 45 |
| BUK-TEE 404 | IoT Mini project | 3 | C | 30 | 45 |
|  | **Total** | **11** |  |  |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **LEVEL 500** | | | | | |
| **CODE** | **COURSE NAME** | **Unit** | **Status** | **LH** | **PH** |
| BUK-TEE 501 | Mobile Communication System | 2 | C | 30 | 15 |
| BUK-TEE 502 | Antenna Theory and Design | 3 | C | 30 | 45 |
| BUK-TEE 503 | Wireless Communication | 2 | C | 30 | 15 |
| BUK-TEE 504 | Satellite Communications | 2 | C | 30 | 15 |
| BUK-TEE 505 | RF and Microwave Engineering | 2 | C | 30 | 15 |
| BUK-TEE 506 | Final Year Project | 6 | C | - | - |
|  | *Elective* | 2 | C | 30 | 15 |
|  | **Total** | **19** |  |  |  |
|  | **Grand Total** | **52** |  |  |  |

# 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-TEE 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-TEE 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-TEE 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-TEE 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-TEE 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-TEE 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-TEE 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-TEE 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-TEE 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-TEE 402 Wireless Sensor Networks, (3 Units; Core; L = 30; P = 45)

## Senate-approved relevance

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

## Overview

Wireless Sensor Networks (WSNs) is an interdisciplinary field that combines computer science, electrical engineering, and information technology to develop networks of small, low-cost, and energy-efficient sensors that can be deployed in various environments for monitoring, control, and data collection.

This course provides an introduction to the fundamental concepts, architectures, protocols, and applications of WSNs.

## Objectives

The learning objectives for the course may include:

1. Understand the fundamental concepts of Wireless Sensor Networks, including their architecture, communication protocols, and data processing.
2. Analyze the performance of WSN protocols, such as MAC and routing protocols, and evaluate their suitability for different WSN scenarios.
3. Develop and implement energy-efficient algorithms for WSNs, including techniques for reducing energy consumption during data transmission and processing.
4. Understand the challenges of localization in WSNs and develop techniques for accurately determining the location of nodes in a network.
5. Understand the security challenges in WSNs, including node authentication, data confidentiality, and privacy protection, and design secure protocols to mitigate these challenges.
6. Apply the concepts learned in the course to design and implement WSNs for specific applications, such as environmental monitoring, smart homes, and industrial automation.

## Learning Outcomes

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

1. Understand the architecture and protocol stack of Wireless Sensor Networks.
2. Identify the requirements of energy efficiency and scalability for WSNs.
3. Apply various MAC and routing protocols in different WSN scenarios.
4. Analyze and compare the performance of different WSN protocols.
5. Understand the issues related to security and privacy in WSNs.
6. Design and implement WSNs for specific applications.

## Course Contents

*Introduction*: Features, Design challenges, Network architecture, Applications, Sensor deployment mechanism, Topologies and characteristics.

*Network and Component Technologies*: Sensors, Coverage, Physical layer, Sensor platforms, Reliable data transport.

*Data Transmission and Routing*: Data processing and aggregation, Data storage, Node discovery algorithms, Wireless sensor network routing, Proactive and reactive routing.

*Protocols*: Frame structure, Network clustering protocols, medium access control protocols, Multi-hop communication protocols, Congestion control and rate control protocols, Protocol overheads.

*Dependability Issues*: Collisions, Collision avoidance mechanism, Hidden node and exposed node problems, Data congestions, Throughput, Security challenges.

## Minimum Academic Standards

Computer Lab with high performance PC

# BUK-TEE 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-TEE 501 Mobile Communication System, (3 Units; Core; L = 30; P = 45)

## Senate-approved relevance

Training of high-quality graduates who are highly skilled in designing and developing mobile communication systems. This is in agreement with BUK’s mission to be forefront in digital world and lead Africa in current technologies.

## Overview

Mobile Communication Systems is a course that covers the principles, technologies, and applications of wireless communication systems for mobile devices. The course focuses on various mobile communication standards, protocols, and architectures.

Mobile Communication Systems courses provide students with a comprehensive understanding of the principles, technologies, and applications of wireless communication systems used in mobile and wireless networks. They prepare students for careers in the field of mobile communication, including roles such as wireless network engineers, mobile system designers, network planners, and researchers in the area of wireless communication

## Objectives

The learning objectives for the course may include:

1. To provide an understanding of mobile communication systems and their components.
2. To develop skills in designing and implementing mobile communication systems.
3. To introduce students to the various mobile communication standards and protocols.
4. To prepare students for careers in mobile communication system design and related fields.

## Learning Outcomes

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

1. Understand the principles and components of mobile communication systems.
2. Design and implement mobile communication systems using various mobile communication standards.
3. Analyze and optimize mobile communication systems for performance and capacity.
4. Evaluate the security and privacy aspects of mobile communication systems.
5. Apply mobile communication system design techniques to solve real-world problems.

## Course Contents

1. Introduction to Mobile Communication Systems: Overview of mobile communication systems, mobile devices, and wireless networks.
2. Mobile Communication Standards: Overview of various mobile communication standards such as GSM, CDMA, LTE, and 5G.
3. Mobile Communication Protocols: Overview of mobile communication protocols such as TCP/IP, SIP, and RTP.
4. Mobile Communication Architecture: Overview of mobile communication architectures such as cellular, satellite, and ad hoc networks.
5. Radio Access Technologies: Overview of radio access technologies such as FDMA, TDMA, CDMA, and OFDMA.
6. Security and Privacy in Mobile Communication Systems: Overview of security and privacy issues in mobile communication systems and their solutions.

## Minimum Academic Standards

Computer Laboratory

# BUK-TEE 502 Antenna Theory and Design, (3 Units; Core; L = 30; P = 45)

## Senate-approved relevance

Training of high-quality graduates who are highly skilled in designing and developing antennas for communication systems. This is in agreement with BUK’s mission to be forefront in digital world and lead Africa in current technologies.

## Overview

Antenna Theory and Design is a course that covers the principles, techniques, and practical applications of designing and analysing antennas. Antennas are critical components of various communication systems, such as radio and TV broadcasting, satellite communication, radar, and wireless networks.

The courses provide students with a solid understanding of the principles, concepts, and design methodologies of antennas. They prepare students for careers in the field of antenna design, wireless communication, radar systems, satellite communication, and other related areas. Students may also gain hands-on experience through laboratory exercises, design projects, and simulations related to antenna design and performance analysis.

## Objectives

The learning objectives for the course may include:

1. Understanding the basic principles of antenna theory, including radiation patterns, antenna impedance, and antenna gain.
2. Understanding the design and analysis of various types of antennas, such as wire antennas, aperture antennas, and array antennas.
3. Understanding the factors that affect antenna performance, including frequency, polarization, and bandwidth.
4. Developing the ability to use electromagnetic simulation software to analyze and design antennas.
5. Understanding the practical issues involved in antenna design, such as manufacturing and cost considerations.
6. Understanding the relationship between antenna design and system performance in applications such as wireless communication, radar, and remote sensing.
7. Developing problem-solving skills related to antenna design, such as selecting appropriate antenna types for specific applications and optimizing antenna performance.
8. Understanding the role of antennas in modern technologies such as 5G networks, satellite communications, and the internet of things.
9. Developing communication skills to effectively convey antenna design concepts and results to technical and non-technical audiences.
10. Developing critical thinking skills to evaluate and analyze emerging trends in antenna technology and apply them to practical problems.

## Learning Outcomes

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

1. analyze and design various types of antennas, such as wire antennas, aperture antennas, and array antennas.
2. explain the basic principles of antenna theory, including radiation patterns, antenna impedance, and antenna gain.
3. use electromagnetic simulation software to analyze and design antennas.
4. evaluate the factors that affect antenna performance, including frequency, polarization, and bandwidth.
5. explain the practical issues involved in antenna design, such as manufacturing and cost considerations.
6. analyze and optimize antenna performance for specific applications such as wireless communication, radar, and remote sensing.
7. select appropriate antenna types for specific applications and justify their selection based on performance metrics.
8. explain the role of antennas in modern technologies such as 5G networks, satellite communications, and the internet of things.
9. communicate antenna design concepts and results effectively to technical and non-technical audiences.
10. evaluate emerging trends in antenna technology and apply them to practical problems.

## Course Contents

Introduction to Antennas: This module provides an introduction to antennas, their function, and their uses in various applications. The module also covers the basic concepts of antenna parameters, radiation patterns, and antenna types.

Antenna Fundamentals: This module covers the fundamental principles of antenna theory, including antenna radiation, antenna impedance, and antenna directivity. The module also covers the basic antenna types and their characteristics.

Antenna Arrays: This module covers the design and analysis of antenna arrays, including the basic principles of array theory, array radiation patterns, and array synthesis. The module also covers the design of phased arrays, their applications, and their limitations.

Antenna Measurements: This module covers the various measurement techniques used to characterize antenna performance, including gain, radiation patterns, and impedance. The module also covers the use of anechoic chambers and network analyzers for antenna measurements.

Microstrip Antennas: This module covers the design and analysis of microstrip antennas, which are widely used in wireless communication systems due to their low profile, light weight, and easy integration with other circuits. The module also covers the different types of microstrip antennas and their applications.

Frequency Selective Surfaces: This module covers the design and analysis of frequency selective surfaces, which are used to control the propagation of electromagnetic waves and are widely used in antenna design. The module also covers the design and implementation of band-pass and band-reject frequency selective surfaces.

Antenna Design Techniques: This module covers the various design techniques used to optimize antenna performance, including the use of computer-aided design (CAD) tools, optimization algorithms, and experimental testing. The module also covers the use of software packages such as HFSS, CST, and MATLAB for antenna design and analysis.

## Minimum Academic Standards

Antenna Laboratory

# BUK-TEE 503 Wireless Communication, (2 Units; Core; L = 30; P = 30)

## Senate-approved relevance

Training of high-quality graduates who are highly skilled in designing and developing wireless communication systems. This is in agreement with BUK’s mission to be forefront in digital world and lead Africa in current technologies.

## Overview

Wireless Communication courses provide students with a solid understanding of the principles, concepts, and technologies used in wireless communication systems. They prepare students for careers in the field of wireless communication, telecommunications, mobile networks, IoT, and other related areas. Students may also gain hands-on experience through laboratory exercises, simulations, and design projects related to wireless communication system design, performance analysis, and standard.

Overall, the course aims to provide students with a solid foundation in wireless communication systems and technologies, enabling them to design, analyze, and optimize wireless networks and systems for various applications.

## Objectives

The learning objectives for the course may include:

1. Understanding the basics of wireless communication systems, including different types of wireless networks and communication protocols.
2. Understanding the physical principles that govern wireless communication, including radio waves, electromagnetic spectrum, and propagation of wireless signals.
3. Understanding the key components of a wireless communication system, such as antennas, transmitters, receivers, and signal processing units.
4. Learning how to design and analyze wireless communication systems, including the use of modelling and simulation tools.
5. Understanding the trade-offs involved in wireless system design, such as power consumption, data rate, and reliability.
6. Learning about the latest advancements and emerging technologies in wireless communication, such as 5G, IoT, and wireless sensor networks.
7. Understanding the security and privacy challenges in wireless communication and the methods for ensuring secure wireless communication.
8. Developing practical skills in wireless communication through lab experiments and project assignments.
9. Understanding the ethical and social implications of wireless communication, such as privacy, accessibility, and environmental impact.

## Learning Outcomes

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

1. Demonstrate a solid understanding of the physical principles of wireless communication and the different types of wireless networks and communication protocols.
2. design and analyze wireless communication systems, including the use of modeling and simulation tools.
3. identify the key components of a wireless communication system, such as antennas, transmitters, receivers, and signal processing units, and describe their function.
4. evaluate the trade-offs involved in wireless system design, such as power consumption, data rate, and reliability.
5. understand the latest advancements and emerging technologies in wireless communication, such as 5G, IoT, and wireless sensor networks.
6. analyze the security and privacy challenges in wireless communication and propose methods for ensuring secure wireless communication.
7. apply practical skills in wireless communication through lab experiments and project assignments.
8. evaluate the ethical and social implications of wireless communication, such as privacy, accessibility, and environmental impact.

## Course Contents

*Introduction to Wireless Communication*: Overview of wireless communication systems and applications, Brief history and evolution of wireless communication, Theoretical foundations of wireless communication, Wireless communication standards and organizations.

*Wireless Channel Modelling:* Radio wave propagation and path loss, Fading channels and their impact on wireless communication, Diversity techniques for combating fading.

*Modulation and Demodulation Techniques*: Analog modulation techniques: amplitude modulation, frequency modulation, Digital modulation techniques: amplitude shift keying (ASK), frequency shift keying (FSK), phase shift keying (PSK), quadrature amplitude modulation (QAM), Error control coding and its application in wireless communication

*Multiple Access Techniques:* Frequency Division Multiple Access (FDMA), Time Division Multiple Access (TDMA), Code Division Multiple Access (CDMA), Orthogonal Frequency Division Multiplexing (OFDM).

*Wireless Networking and Protocols*: Wireless local area network (WLAN) technologies and protocols, Cellular network architectures and protocols, Mobile Ad Hoc Network (MANET) protocols, Wireless Sensor Network (WSN) protocols

*Wireless Security and Privacy:* Wireless security threats and challenges, Security protocols for wireless communication, Privacy protection techniques for wireless communication

*Emerging Wireless Technologies:* 5G and beyond: features, architecture, and applications

Internet of Things (IoT): wireless communication requirements and challenges, Wearable and implantable wireless devices.

## Minimum Academic Standards

Computer Lab with high performance PC and wireless devices

# BUK-TEE 504 Satellite Communications, (2 Units; Core; L = 30; P = 30)

## Senate-approved relevance

Training of high-quality graduates who are highly skilled in designing and developing satellite technology for transmitting and receiving information over long distances. This is in agreement with BUK’s mission to be forefront in digital world and lead Africa in current technologies.

## Overview

Satellite Communications is a field of study that focuses on the design, analysis, and operation of communication systems that use satellite technology for transmitting and receiving information over long distances. The course covers the principles of satellite communication, the design of satellite systems, and the applications of satellite communication in various domains. The course typically includes lectures, lab sessions, and project work to provide practical experience in designing and analysing satellite communication systems.

The course aims to provide students with a thorough understanding of satellite communication technology and its applications, enabling them to design, operate and optimize satellite communication systems for various domains

## Objectives

The learning objectives for the course may include:

1. Understanding the principles of satellite communication, including the physics of electromagnetic wave propagation, antenna theory, and satellite orbits.
2. Understanding the design of satellite communication systems, including the selection of frequencies, modulation schemes, and error correction codes.
3. Understanding the applications of satellite communication in various domains, such as telecommunications, broadcasting, remote sensing, navigation, and military communication.
4. Being able to analyze the link budget of satellite communication systems, including the calculation of path loss, antenna gain, and noise temperature.
5. Being able to design and operate Earth stations for satellite communication, including antenna design, amplifiers, and signal processing.
6. Understanding the protocols and standards used in satellite communication, including multiple access techniques and error control coding.
7. Understanding the architecture of satellite communication networks, including inter-satellite links, gateway stations, and ground segment.
8. Understanding the emerging technologies and applications in satellite communication, such as High Throughput Satellites (HTS), Small Satellites, and CubeSats.
9. Being able to work in a team to design and implement a satellite communication system.
10. Developing critical thinking skills and problem-solving skills through the course assignments, lab sessions, and project work.
11. Developing effective communication skills to present technical information to a non-technical audience

## Learning Outcomes

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

1. Explain the fundamentals of satellite communication systems, including satellite orbits, link budget analysis, and satellite subsystems such as antennas, transmitters, and receivers.
2. design and analyze satellite communication systems, including the selection of appropriate frequencies, bandwidth, and modulation schemes.
3. explain the applications of satellite communication in various domains, such as telecommunications, broadcasting, remote sensing, navigation, and military communication.
4. explain the protocols and standards used in satellite communication, including multiple access techniques and error control coding.
5. design and operate Earth stations for satellite communication, including antenna design, amplifiers, and signal processing.
6. analyze the performance of satellite communication systems, including link margin, bit error rate, and signal-to-noise ratio.
7. work in a team to design and implement a satellite communication system.

## Course Contents

Introduction to Satellite Communication Systems: Overview of satellite communication systems, satellite orbits, and link budget analysis.

Satellite System Design: Design considerations for satellite communication systems, including power, frequency, and bandwidth allocation, and satellite subsystems such as antennas, transmitters, and receivers.

Satellite Communication Applications: Applications of satellite communication, including telecommunications, broadcasting, remote sensing, navigation, and military communication.

Satellite Communication Protocols: Standards and protocols used in satellite communication, including modulation schemes, multiple access techniques, and error control coding.

Earth Station Design: Design and operation of Earth stations for satellite communication, including antenna design, amplifiers, and signal processing.

Satellite Network Architecture: Overview of the architecture of satellite communication networks, including inter-satellite links, gateway stations, and ground segment.

Satellite Communication System Performance: Analysis of system performance metrics, including link margin, bit error rate, and signal-to-noise ratio.

Emerging Technologies: Overview of emerging technologies and applications in satellite communication, including High Throughput Satellites (HTS), Small Satellites, and CubeSats.

## Minimum Academic Standards

Computer Lab with high performance PC and wireless devices

# BUK-TEE 505 RF and Microwave Engineering, (2 Units; Core; L = 30; P = 30)

## Senate-approved relevance

Training of high-quality graduates who are highly skilled in designing and implementation of radio frequency (RF) and microwave systems and circuits. This is in agreement with BUK’s mission to be forefront in producing graduate that are ready for the industries.

## Overview

RF and Microwave Engineering is a field of study that deals with the design, analysis, and implementation of radio frequency (RF) and microwave systems and circuits. The course provides students with a solid foundation in the principles of RF and microwave engineering, and covers topics such as microwave transmission lines, microwave networks, microwave components, and microwave measurements. Overall, the course aims to provide students with a comprehensive understanding of the principles and techniques of RF and microwave engineering, enabling them to design and optimize RF and microwave systems and circuits for various applications.

Students are expected to develop a deep understanding of the technical and operational aspects of RF and microwave engineering and develop the skills to analyze and optimize RF and microwave systems and circuits for various applications.

## Objectives

The learning objectives for the course may include:

1. Understanding the principles of electromagnetic theory and wave propagation, and how these principles are applied in RF and microwave engineering.
2. Understanding the characteristics of transmission lines, waveguides, and other microwave components, and being able to design and analyze them for specific applications.
3. Understanding the design and analysis of microwave networks, including impedance matching, power dividers, and directional couplers.
4. Understanding the design and analysis of microwave components, including filters, amplifiers, mixers, and oscillators.
5. Understanding the measurement techniques and instruments used in RF and microwave engineering, including network analyzers, spectrum analyzers, and power meters.
6. Understanding the design and analysis of RF and microwave circuits, including amplifiers, oscillators, mixers, and filters.
7. Understanding the design and analysis of microwave antennas, including antenna radiation patterns, antenna arrays, and aperture antennas.
8. Being able to design and optimize RF and microwave systems and circuits for various applications.
9. Developing critical thinking skills and problem-solving skills through the course assignments, lab sessions, and project work.
10. Developing effective communication skills to present technical information to a non-technical audience.

## Learning Outcomes

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

1. Design and analyze microwave networks, including impedance matching, power dividers, and directional couplers, for specific applications.
2. Design and analyze microwave components, including filters, amplifiers, mixers, and oscillators, for specific applications.
3. Use measurement techniques and instruments to characterize and optimize the performance of RF and microwave systems and circuits.
4. Design and analyze RF and microwave circuits, including amplifiers, oscillators, mixers, and filters, for specific applications.
5. Design and analyze microwave antennas, including antenna radiation patterns, antenna arrays, and aperture antennas, for specific applications.
6. Develop critical thinking skills and problem-solving skills through the course assignments, lab sessions, and project work.
7. Develop effective communication skills to present technical information to a non-technical audience.
8. Understand the impact of RF and microwave engineering on modern communication systems and emerging technologies, and be able to apply the principles and techniques of RF and microwave engineering to the design of advanced communication systems.

## Course Contents

Introduction to RF and Microwave Engineering: Overview of RF and microwave systems, frequency spectrum, and electromagnetic theory.

Microwave Transmission Lines: Characterization and analysis of transmission lines, including microstrip, stripline, and waveguide.

Microwave Networks: Design and analysis of microwave networks, including impedance matching, power dividers, and directional couplers.

Microwave Components: Design and analysis of microwave components, including filters, amplifiers, mixers, and oscillators.

Microwave Measurements: Techniques and instruments used for microwave measurements, including network analysers, spectrum analysers, and power meters.

Microwave System Design: System-level design of microwave communication systems, including link budget analysis, system optimization, and system performance analysis.

RF and Microwave Circuit Design: Design and analysis of RF and microwave circuits, including amplifiers, oscillators, mixers, and filters.

## Minimum Academic Standards

Computer Lab with high performance PC and wireless devices