Column1	Column2	Column3	Column4	Column5
#NAME?				
#NAME?	Table of Contents			

Column1	Column2	Column3	Column4	Column5	Column6
	Data Sources & Bibliography				
	Experimental Topics:				
	Data from St. Peace College, Tshingombe, and various online databases.				
	Recommended Reading:				
	Books, articles, and papers on electrical systems, engineering dynamics, and electrodynamics.				
	3.1.2.7.6.19.**4. Assignment and Project Guidelines**				
	3.1.2.7.6.19.**4.1 Assignment Title**				
	Engineering Electrical Master				
	Topics such as electrostatics, electrokinematics, electrodynamics, and power systems control.				
	3.1.2.7.6.19.**4.2 Assignment Structure**				
	Course Index:				
	A comprehensive breakdown of basic concepts, diagrams, and case studies such as load shedding, Eskom, and Schneider Electric.				
	Research and Case Studies:				
	Real-world scenarios will be presented, such as city power systems and industrial control challenges.				
	Justification & Practical Examples:				
	Analysis of the advantages and disadvantages of current systems, highlighting issues like poor distribution and inefficiency in trade systems.				
	3.1.2.7.6.19.**5. Topics for Study and Exploration**				
	3.1.2.7.6.19.**5.1 Introduction & Purpose**				
	Key Definitions:				
	Introduce critical concepts in electrical engineering, focusing on how system design and stability play a pivotal role in modern industry.				

5.2 Description of Topics

A range of subtopics such as:

Signal detection, wireless systems, telecommunication technologies, neural networks, and biological systems.

Examples:

Digital Control Systems, Microprocessors, and Stochastic Processes.

6. Advanced Topics in Electrical Engineering

6.1 Topics Covered:

- Digital Telephony
- Space Control Systems
- Advanced Telecommunications
- Wireless Telecommunication Systems
- Neural Networks and Signal Processing
- Signal Detection and Estimation Theory
- Industrial Power Systems and Process Control

6.2 Course Focus Areas:

Understanding the interaction between electromagnetic systems, signal processing, and power systems control.

Exploring topics like fiber optics, biological computation, signal redressing, and medical image reconstruction.

3.1.2.7.6.19.7. Additional Course Components

3.1.2.7.6.19.7.1 Educational Development:

The course aims to advance knowledge in engineering, focusing on technical skills and soft skills like critical thinking and innovation in industrial design.

3.1.2.7.6.19.7.2 Professional Evaluation:

Evaluation of developmental theories and the impact of technological changes in the engineering sector.

3.1.2.7.6.11.1.8.3 Approach:

The research will take a holistic approach to vocational education within the engineering sector, exploring how the system can be restructured for better performance and faster responses to evolving e

Online Education and Career Development:

The approach will assess the role of online education platforms and career centers in engineer education. Special attention will be given to security and privacy concerns related to student data, acade

Rural Justice and Social Media:

The study will also consider social media and rural justice systems, analyzing how mediation, conciliation, and policy development through these platforms can contribute to solving vocationa

3.1.2.7.6.12.1.7 Theoretical Framework:

The theoretical framework for this research focuses on practical, philosophical, and regulatory aspects of vocational engineering education, with a particular emphasis on electrical engineering and its int

Key Aspects of the Theoretical Framework:

1. Philosophies of Education:

The framework will draw on various philosophies of education, emphasizing the practical application of engineering concepts and the development of critical thinking and problem-solving skills in voca

It will involve examining cognitive processes involved in learning, including how students process, analyze, and apply information in real-world engineering tasks.

2. Curriculum Implementation:

The study will evaluate how the qualification curriculum is designed and implemented, including aspects like:

The design of career-oriented modules.

Time allocation for theory vs. practical work.

Alignment with national framework standards and assessment guidelines.

3. Irregularities in Education:

The framework will focus on identifying and addressing irregularities in:

Marking schemes and record-keeping.

The design of time tables and the allocation of learning hours.

Assessments and results release issues that undermine the credibility of the system.

4. Regulations and Policy:

Focus on regulatory frameworks guiding vocational education and the role of SETAs (Sector Education and Training Authorities), particularly the EDPSETA (Engineering, Development and Professional S

Examination of the philosophy behind the National Qualifications Framework (NQF) and how it impacts the engineering education system in rural areas.

5. Integration with the National Framework:

Conceptual integration of educational practices with the national framework ensuring that learning outcomes are consistently aligned with industry standards and national policies.

This includes the role of School Governing Bodies (SGBs) and other stakeholders in shaping curricula and assessments.

3.1.2.7.6.13.**1.8 Methodological Approach:**

The methodology will focus on analyzing the education system's practices in vocational engineering institutions, including system design, assessment practices, and data management. It will include the e

Key Elements of the Methodological Approach:

1. Teaching System and Policies:

Study the teaching and assessment systems used in vocational colleges and engineering academies, focusing on the semester design, curriculum delivery, and outcomes assessment.

2. Systematic Evaluation:

Evaluate how timetables and teaching methods in engineering are designed to ensure students receive both theoretical knowledge and practical experience. The study will look into whether these sys

3. Trade-Related Manufacturing Systems:

Explore engineering dockets and portfolios that track the progress of students in applied fields such as electrical engineering.

Identify gaps or irregularities in the manufacturing and assessment systems and propose improvements.

4. System Failures:

Analyze areas where systemic failures such as slow marking, delayed results, and inconsistent feedback have led to student dissatisfaction and academic inconsistencies.

Focus on developing new methods to resolve these issues in a timely and efficient manner.

5. Engineering Systems and Registration:

The research will assess how registration processes work for engineering students, particularly the suspension of assessments and how these processes can be streamlined or reformed.

6. Assessment Design and Evaluation:

A comprehensive look at assessment processes—whether mark sheets are accurate, grades are timely, and how feedback is integrated into the development of students' skills.

1.8.2 Research Design:

The **research design** for this study centers on creating an **engineering model** that highlights the relationship between **academic outcomes**, **curriculum implementation**, and **real-world application**.

Field-Based Model:

Develop a model that includes both **academic and practical assessments**, allowing for an integrated approach to evaluating students' engineering competencies.

Create **outcome-based assessments** that are aligned with **national qualification standards** and **industry needs**.

3.1.2.7.6.14.**1.8.3 Approach:**

The study will adopt a multifaceted approach that integrates traditional learning environments with the advent of online education systems and other technology-based solutions to improve vocational tr

Key Aspects:

1. Industrial Education System:

The research will consider the targeted outcomes of industrial education, including skills development, career orientation, and the integration of educational technology into vocational programs.

2. Online and Social Media Approaches:

Examine the use of online platforms, social media tools, and career development centers as part of the educational system. These platforms can help rural students access better learning resources an

3. Rural Justice and Education:

Investigate the intersection of justice systems, education policies, and social development in rural areas, especially how these elements influence educational outcomes for vocational learners in engineer

3.1.2.5.power Systems and Renewable Energy

Optimization of Microgrid Systems

Investigating AI-driven optimization for hybrid renewable microgrids.

Case study on cost-benefit analysis of microgrids in remote areas.

Smart Grid and Energy Storage Technologies

Enhancing demand response strategies using machine learning.

Optimization of battery energy storage for grid stabilization.

Wireless Power Transmission

Developing high-efficiency resonant inductive coupling systems.

Applications of wireless power transfer in electric vehicles.

3.1.2.5.2. Control Systems and Automation

AI-Based Predictive Maintenance in Industrial Systems

Machine learning for fault detection in power transformers.

Predicting failures in rotating machinery using deep learning.

Advanced Robotics and Control Algorithms

Adaptive control for autonomous robotic arms.

Path optimization algorithms for multi-agent robotic systems.

IoT-Based Smart Home Automation

Implementing AI-driven smart home systems for energy efficiency.

Secure communication protocols for IoT-based automation.

3.1.2.5.3. Embedded Systems and Internet of Things (IoT)

Edge Computing for IoT Devices

Implementing real-time AI inference in low-power embedded systems.

Optimization of edge computing frameworks for industrial IoT.

Wearable Health Monitoring Devices

Developing ECG monitoring using flexible sensors and AI analysis.

Low-power IoT solutions for real-time health monitoring.

3.1.2.5.4. Signal Processing and Telecommunications

5G and Beyond: Enhancing Wireless Communications

AI-driven beamforming techniques for 6G networks.

Security enhancements in millimeter-wave 5G networks.

Speech and Image Processing Using AI

Deep learning-based speech enhancement for hearing aids.

Real-time image recognition for autonomous navigation.

3.1.2.5.5. Electric Vehicles and Sustainable Transportation

Battery Management Systems for Electric Vehicles

AI-enhanced state-of-charge prediction for EV batteries.

Ultracapacitor integration for extended EV range.

Inductive Charging for Electric Vehicles

Wireless power transfer optimization for fast charging.

Roadway-embedded charging systems for continuous power.

3.1.2.5.6. Biomedical Engineering and Assistive Technologies

Neural Interfaces for Brain-Computer Interaction

EEG-based control systems for prosthetic devices.

AI-driven signal processing for seizure detection.

Smart Prosthetics and Exoskeletons

Sensor fusion for adaptive gait control in lower-limb exoskeletons.

AI-driven gesture recognition for upper-limb prosthetics.

Would you like a **detailed methodology or research proposal** on any of these topics?

.1.2.7.6.26.Electrician Sector Projects and Training

1. Trade Duration & National Qualification:
   Duration: 2 years for electrical trade with different semesters.
   Hours & Practical Skills:
      Practical visits to transmission and distribution substations for 10 hours.
      Tasks include drawing actual circuit diagrams, assembling solar panels, and understanding the principles of power generation by solar, wind, and other non-conventional methods.
2. Practical Skills & Circuit Installation:
   Overhead Domestic Service Line Installation: Erecting overhead service lines and connecting them to a 230V distribution system.
   Practical Installation of Insulators: Used in low-tension (LT) lines for safety.
   Circuit Breakers & Relays: Troubleshooting and repairing faults in circuit breakers, setting up current multipliers for relay operations, and testing tripping characteristics for current and short circuits.
   Transmission and Distribution: Understanding line insulators, overhead poles, and methods of joining conductors.
3. Solar Power Systems & Electrical Installations:
   Solar Panel Systems: Preparation of layout plans and identification of different components in solar systems. Erecting overhead lines and ensuring proper electrical connections.
   Wind Power: Understanding the principles and operation of wind energy systems alongside other renewable energy sources.
4. Assessment & Industrial Visits:
   Electrical work assessments, including DC voltage control circuits, alarm systems using sensors, and basic electrical principles like resistance measurement.
   Industrial visits to power plants and substations to observe real-world applications of electrical systems.
5. Theory and Practical Application:
   Electrical Theory: Includes learning about magnetism, electromagnetism, and using measurement instruments like multimeters.
   Project Work: Involves designing circuits for various electrical applications, such as controlling motor pumps and providing emergency light solutions.

Advanced Power Engineering & Systems Projects

1. Electric Power Engineering:
   SCADA Systems: Learning how power grids are managed with SCADA (Supervisory Control and Data Acquisition) systems.
   Transmission & Protection: Gaining knowledge on the protection systems for transformers and transmission lines.
   Photovoltaic Power & Wind Power Systems: Investigating renewable energy sources and understanding the functioning of photovoltaic and wind power plants.
2. Fundamentals of Power Engineering:
   AC, DC, and Three-Phase Technology: Understanding the basics of alternating current (AC), direct current (DC), and three-phase systems.
   Generator Protection: Studying protection mechanisms for generators in the power grid.
3. Experimental Work & Research:
   Measuring the Band Gap of Semiconductors: A fundamental experiment in electrical engineering, focusing on material properties.
   Thermoelectric and Electromagnetic Experiments: Investigating thermoelectric effects, induction voltage, and thermodynamic cycles of heat pumps.
   Magnetic Field Measurement: Using apparatus like a Teslameter to measure the magnetic field generated by current flowing through coils.

Objective and Educational Aims

The primary goal of these projects is to:

- Equip learners with both practical and theoretical knowledge required in the electrical trade, especially focusing on electrical installations, solar power, wind power, and troubleshooting electrical syste
- Prepare students for the evolving electrical power engineering industry, providing them with the necessary skills to work with complex systems such as power grids, transmission lines, and renewable e
- Foster critical thinking and hands-on skills through the completion of industrial visits, project work, and practical experiments.

Key Learning Outcomes

Understanding the **fundamentals of electrical power systems** and their operation.
Gaining **hands-on experience** with real-world electrical installations and troubleshooting.
Understanding **renewable energy technologies** and their application in modern power generation.
Learning to use **advanced measurement tools** and equipment for electrical systems testing and diagnostics.

3.1.2.7.6.25.2.Project Topic Overview: Fundamentals of Power Electronics

The course structure for **Power Electronics** typically covers a comprehensive set of topics related to the fundamental concepts and applications of power electronics systems. Below is an outline of the co

Course Structure

1. **Introduction to Power Electronics**

Lecture Hours: Introduction to the field of power electronics, its significance, and its various applications in modern electrical systems. Key topics include basic principles and terminology.

2. **Semiconductor Devices**

Lecture Hours: Overview of different semiconductor devices used in power electronics, such as diodes, transistors (BJTs, MOSFETs, IGBTs), and thyristors.
Key Areas: Working principles, characteristics, and applications of these devices in switching and control.

3. **Review of Electrical Concepts**

Lecture Hours: A brief review of essential electrical concepts such as voltage, current, resistance, power, and energy. The focus is on how these concepts relate to power electronic devices and circuits

4. **Line Frequency Diode Rectifiers**

Lecture Hours: The study of basic rectification circuits using diodes, including half-wave and full-wave rectifiers, and the conversion of AC to DC power at line frequency.
Key Areas: Efficiency, output waveforms, and harmonic distortion.

5. **Line Frequency Phase Controlled Rectifiers**

Lecture Hours: Exploration of phase-controlled rectifiers (such as thyristor-based rectifiers) to control the output DC voltage using phase control techniques.
Key Areas: Applications in power systems and industrial control.

6. **DC-DC Switch Mode Converters**

Lecture Hours: In-depth study of various types of DC-DC converters such as buck, boost, and buck-boost converters.
Key Areas: Efficiency, switching frequency, and applications in power supply circuits.

7. **Pulse-Width Modulation (PWM) with Bipolar and Unipolar Switching**

Lecture Hours: The role of PWM in controlling switch-mode power supplies.
Key Areas: Bipolar vs. unipolar switching, voltage regulation, and modulation techniques.

8. **Switch Mode DC-AC Inverters**

Lecture Hours: Study of inverters that convert DC to AC, including basic topologies like square wave, sine wave, and modified sine wave inverters.
Key Areas: Power factor, efficiency, and applications in renewable energy systems like solar power.

9. **Power Supply Applications**

Lecture Hours: The design and application of power supplies for various uses such as industrial equipment, consumer electronics, and renewable energy systems.
Key Areas: Voltage regulation, filtering, and noise suppression techniques.

10. **Motor Drive Applications**

Lecture Hours: Power electronic circuits used in controlling electric motors, including DC motors, induction motors, and stepper motors.
Key Areas: Speed control, torque control, and motor drive techniques.

11. **Computer Lab**

Lab Hours: Hands-on sessions where students simulate, design, and test power electronics circuits using software tools such as MATLAB/Simulink or PSPICE.
Key Areas: Simulation of converters, inverters, and other power electronic devices.

Power Program Lab Structure

The Power Program Lab focuses on practical, hands-on experience with power electronics systems, including a variety of experiments and real-time testing of electrical equipment.

Equipment: The lab is typically equipped with power poles, power supply units, voltmeters, oscilloscopes, and other essential measurement and testing tools.
Lab Activities:
Combination of Total Methods: A blend of theoretical and practical approaches to designing, testing, and troubleshooting power electronic circuits.
Structure and Applications: Focuses on the structure of power electronics systems, including converters, inverters, and motor control applications.

Key Lab Topics:

DC-DC Converters: Designing and simulating buck and boost converters for voltage regulation.
Inverter Testing: Testing and measuring the efficiency of DC-AC inverters.
Power Supply Systems: Building and analyzing regulated power supplies and their performance.
Motor Drive Systems: Designing and testing variable-speed motor control circuits using PWM.

Learning Outcomes

By the end of this course, students should be able to:

Understand and apply semiconductor devices for switching and rectification.
Design and analyze rectifier and converter circuits for different power electronic applications.
Implement PWM techniques for controlling power supplies and motor drives.
Gain practical experience in laboratory-based simulations and real-world power electronics applications.

1. Magnetism and Electromagnetism (Biot-Savart Law)

In the lab, you'll encounter experiments that involve magnetic fields produced by electric currents. One of the most relevant laws for this purpose is the Biot-Savart Law, which gives the magnetic field ge

Biot-Savart Law:

The law is mathematically expressed as:

B=μ04π∫Idl×r^r2\mathbf{B} = \frac{\mu_0}{4\pi} \int \frac{I \, d\mathbf{l} \times \hat{r}}{r^2}B=4πμ0∫r2Idl×r^

Where:

B\mathbf{B}B is the magnetic field at a point,
μ0\mu_0μ0 is the permeability of free space,
III is the current,
dld\mathbf{l}dl is the infinitesimal length of the current element,
r^\hat{r}r^ is the unit vector pointing from the current element to the point where the field is being calculated,
rrr is the distance from the current element to the observation point.

This equation helps calculate the magnetic field produced by a current-carrying conductor at any point in space. When you're dealing with coils and solenoids, this law becomes essential in determining h

Integral Derivation:

The integral form of the Biot-Savart Law essentially sums (integrates) the contributions of all infinitesimal current elements (dld\mathbf{l}dl) along the conductor to determine the resultant magnetic field

If you have a current flowing in a straight conductor, the magnetic field at a distance rrr from the conductor can be derived from this law by setting up the appropriate integration. For a straight, infinite c

B=μ0I2πrB = \frac{\mu_0 I}{2 \pi r}B=2πrμ0I

2. Magnetic Field in Air Coil Experiment

For your experiment involving the **magnetic field of a long air coil**, you're measuring the magnetic field BBB generated by current flowing through the coil. The objective is to understand how the magneti

The magnetic field inside a long solenoid (or air coil) can be calculated using Ampère's Law:

B=μ0nIB = \mu_0 n IB=μ0nI

Where:

- BBB is the magnetic field inside the coil,
- μ0\mu_0μ0 is the permeability of free space,
- nnn is the number of turns per unit length of the coil,
- III is the current flowing through the coil.

This relationship shows that the magnetic field strength is directly proportional to both the current III and the number of turns per unit length nnn. The experiment involves adjusting these parameters an

3. Transformer Protection and Power Transmission

In the power systems lab, you might also look at the **protection of transformers** and **power transmission** systems. In this case, experiments focus on measuring fault currents, testing protection relays, an

4. Three-Phase Systems and Transmission Line Faults

In power systems, **three-phase** transmission lines are crucial. Faults in transmission lines (e.g., line-to-ground faults, line-to-line faults) can cause significant disruptions, and it's important to understand h

5. Photovoltaic and Wind Power Systems

The lab also involves studying renewable power systems like **photovoltaic** (solar) and **wind power**. These systems convert solar and wind energy into electrical power, which involves understanding the **cc**

Experimental Procedure for Magnetic Field Measurement:

In your experiment measuring the magnetic field around an air coil, the procedure involves:

1. **Set Up**: Connect the coils to the high-current power supply and position the Tesla meter and Hall sensor at different locations around the coil.
2. **Measurement**: Vary the current and record the magnetic field at different points along the coil using the Tesla meter. Ensure you adjust the position of the probe to capture the changes in the magne
3. **Repeat the Experiment**: For different numbers of turns and coil lengths, repeat the experiment to understand how the magnetic field varies with these parameters.

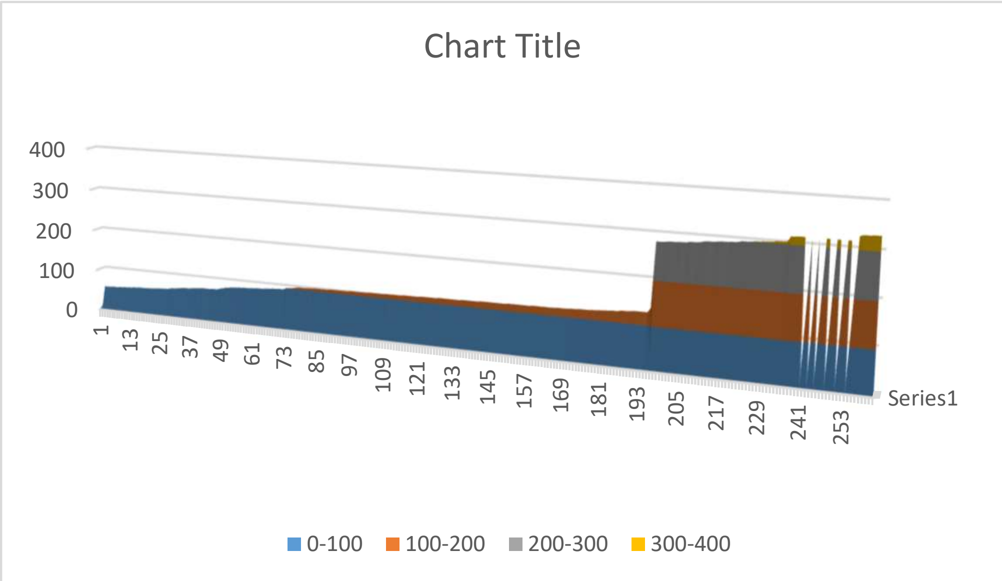

Chart Title
400
300
200
100
0
1
13
25
37
49
61
73
85
97
109
121
133
145
157
169
181
193
205
217
229
241
253
Series1
0-100
100-200
200-300
300-400

Column7	Column8	Column9	Column10	Column11	Column12	Column13	Column14	Column15	Column16	Column17	Column18	Column19	Column20	Column21	Column22

ducational needs.

mic performance, and the integration of online platforms into rural settings.

on challenges.

egration with the national qualification framework (NQF).

ıtional students.

ṡkills Authority).

valuation of trade-related training, particularly electrical engineering, and propose changes to improve the quality and transparency of education.

tems are flexible enough to cater to changing educational needs.

raining in engineering.
d real-time feedback.
rin

1

1.2

ms.

energy systems.

urse structure, with topics and key areas of study:

.

nerated by a small current element.

ow the magnetic field behaves depending on the geometry and current in the conductor.

at a point in space.

onductor, the result would give the magnetic field as:

ic field strength varies with different parameters such as current, coil length, and the number of turns.

nd measuring how the magnetic field changes as a result.

d investigating the effectiveness of protection schemes.

ow these faults are managed and how protection systems respond.

onversion efficiency, power output, and the role of inverters for efficient power generation and integration into the grid.

etic field.