



JOMO KENYATTA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY
SCHOOL OF ELECTRICAL, ELECTRONIC AND INFORMATION ENGINEERING
DEPARTMENT OF ELECTRONIC AND COMPUTER ENGINEERING
DBMS PROJECT REPORT
GROUP 5 MEMBERS

<u>NAME</u>	<u>ADMISSION</u>
GEORGE JOHN OCHIERE	ENE212-0281/2021
MUGAISI EUGENE MURULI	ENE212-0083/2020
KOECH CINDY CHEBET	ENE212-0069/2020
KIRUI ABIGAEL CHEROTICH	ENE212-0070/2020
IAN KIOGORA MWENDA	ENE212-0251/2021

COURSE: B.Sc. ELECTRONIC AND COMPUTER ENGINEERING

ICS 2206

INTRODUCTION TO DATABASE MANAGEMENT SYSTEMS

TITLE: KENYA POWER ELECTRICAL SYSTEMS MANAGEMENT APPLICATION

LECTURER: MR. PETER M KARANJA

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PART I: PROJECT DOCUMENTATION

1. Executive Summary

1.1 Project Overview

The Kenya Power Electrical Systems Management Application is a comprehensive web-based solution designed to manage electrical utility operations for Kenya Power. The system provides two distinct portals:

1. **Staff Portal:** For Kenya Power employees (administrators, managers, technicians, and customer service agents) to manage customers, electrical connections, fault reports, maintenance schedules, and generate performance reports.
2. **Customer Portal:** A self-service interface for Kenya Power customers to view their connections, report faults, submit service requests, communicate with customer support, and manage their profiles.

1.2 Key Features

- **Customer Management:** Complete CRUD operations for customer accounts with unique account numbering
- **Connection Management:** Track electrical connections/meters with status management
- **Fault Management:** Report, assign, track, and resolve electrical faults
- **Maintenance Scheduling:** Schedule and track preventive and corrective maintenance
- **Performance Reporting:** Analytics dashboards with charts and KPIs
- **Role-Based Access Control:** Four staff roles with granular permissions
- **Real-Time Notifications:** System notifications for important events

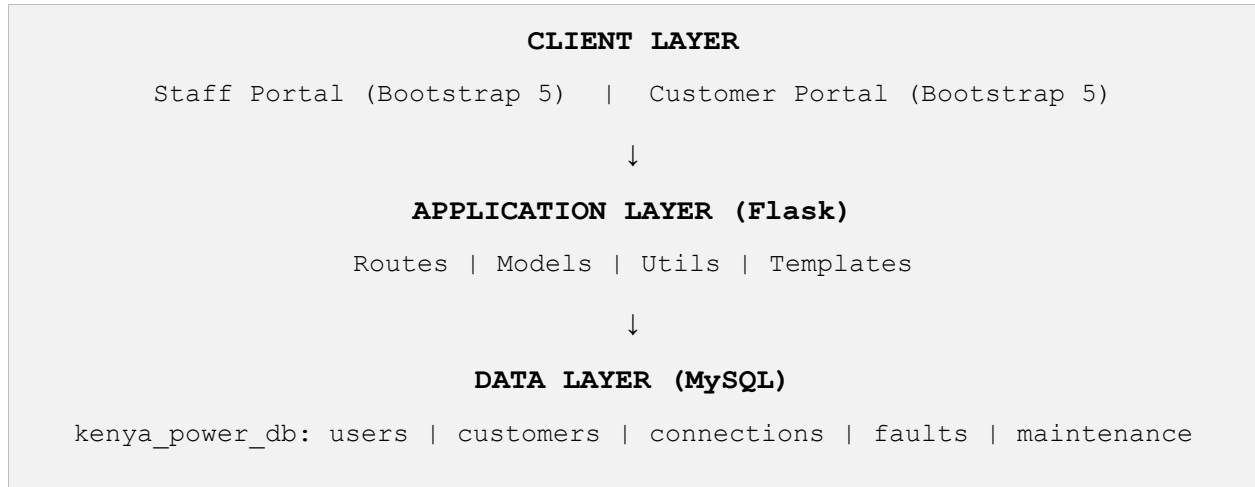
1.3 Technology Stack

Technology	Purpose	Justification
Python Flask	Web Framework	Lightweight, flexible, extensive ecosystem
MySQL	Database	Industry-standard RDBMS, ACID compliance
SQLAlchemy	ORM	Pythonic database operations, relationship management
Flask-Login	Authentication	Secure session management for staff users
Bootstrap 5	UI Framework	Responsive design, modern components
Jinja2	Templating	Server-side rendering, template inheritance

2. System Architecture

2.1 High-Level Architecture

The application follows a three-tier architecture pattern:



2.2 Blueprint Architecture

The application is organized into 9 blueprints:

Blueprint	URL Prefix	Purpose
auth_bp	/	Staff authentication (login, logout, register)
main_bp	/	Landing page and dashboard
customers_bp	/customers	Customer account management
connections_bp	/connections	Electrical connection management
fauls_bp	/fauls	Fault reporting and tracking
maintenance_bp	/maintenance	Maintenance scheduling
reports_bp	/reports	Performance reporting and analytics
staff_bp	/staff	Staff member management (admin only)
customer_bp	/portal	Customer self-service portal

3. Database Design

3.1 Entity-Relationship Diagram

The following diagram illustrates the complete database schema with all 10 interconnected tables:

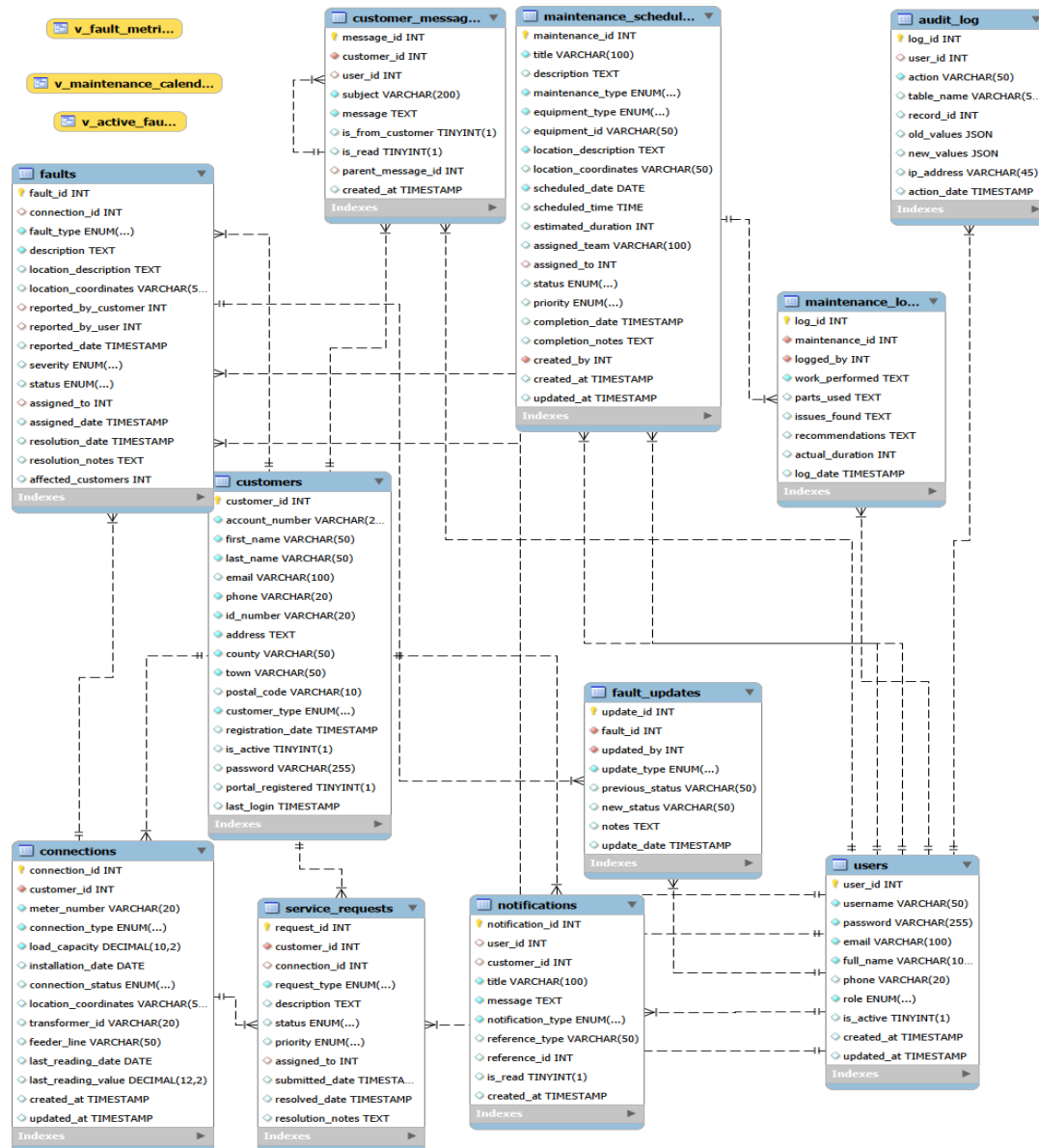


Figure 1: Entity-Relationship Diagram

3.2 Database Tables Overview

Table	Description
users	Staff/admin accounts for system authentication and authorization
customers	Kenya Power customer information and portal credentials
connections	Electrical connections/meters linked to customers
faults	Electrical fault reports with full lifecycle tracking
fault_updates	Status changes and notes added to fault reports
maintenance_schedules	Scheduled maintenance activities with assignments
maintenance_logs	Work performed during maintenance activities
service_requests	Customer service requests (new connection, upgrade, etc.)
notifications	System notifications for users and customers
customer_messages	Two-way messaging between customers and support staff

3.3 Key Relationships

- **Customer → Connections:** One-to-Many (a customer can have multiple electrical connections)
- **Connection → Faults:** One-to-Many (a connection can have multiple fault reports)
- **Fault → FaultUpdates:** One-to-Many (a fault can have multiple status updates)
- **User → Faults:** One-to-Many (technicians are assigned to faults)
- **MaintenanceSchedule → MaintenanceLogs:** One-to-Many (maintenance can have multiple work logs)

4. Authentication and Authorization

4.1 Dual Authentication System

The application implements two separate authentication systems:

Staff Authentication (Flask-Login)

- **Library:** Flask-Login with server-side session management
- **User Model:** User class extending UserMixin

Customer Authentication (Custom Session)

- **Implementation:** Custom session-based authentication in app/utils/customer_auth.py
- **Storage:** Flask session with customer_id tracking

4.2 Role-Based Access Control Matrix

Role	Customers	Connections	Faults	Maintenance	Reports	Staff
Admin	Full	Full	Full	Full	View	Full
Manager	Full	Full	Full	Full	View	None
Technician	View	Add/Edit	Assigned	Assigned	None	None
Customer Svc	Full	View	Report	View	None	None

PART II: USER GUIDE & VERIFICATION

5. Design Objectives Verification

This section details each design objective with step-by-step procedures to demonstrate compliance.

5.1 Customer Connection Management

OBJECTIVE: Track customer connections, handle connection requests, manage installation dates, and monitor service status.

Requirement	Status	Implementation
Track customer connections	MET	Connection model with full lifecycle tracking
Connection requests	MET	ServiceRequest model with new_connection type
Installation dates	MET	installation_date field in Connection model
Service status	MET	connection_status: pending/active/suspended/disconnected

HOW TO PROVE THIS OBJECTIVE IS MET:

3. Login as admin at /login

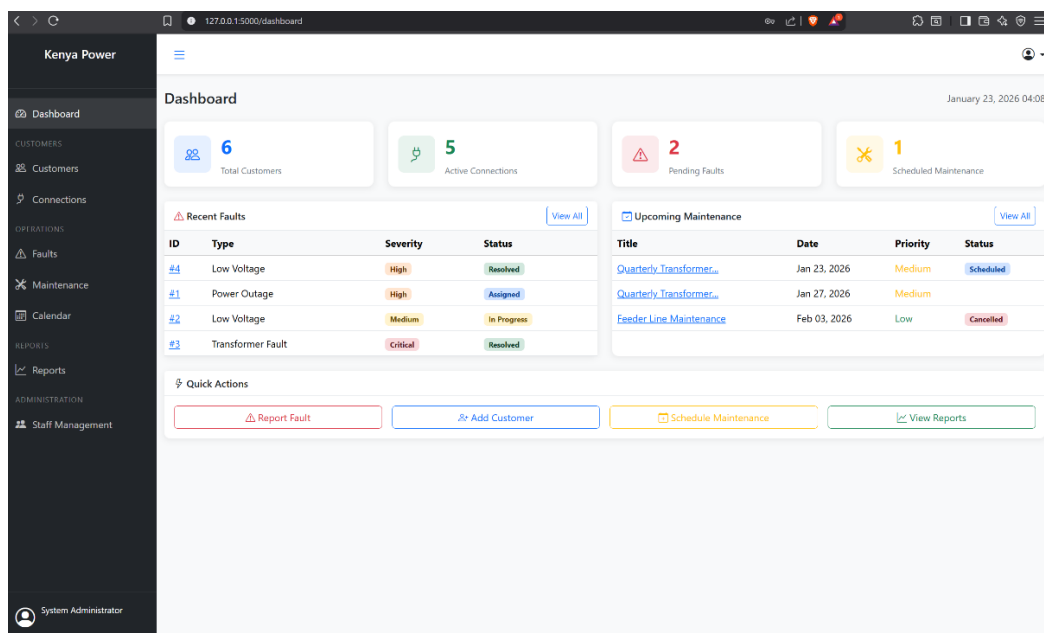


Figure 2: System Administrator's Dashboard

4. Navigate to Customers > Add Customer to create a new customer

Kenya Power

Dashboard
CUSTOMERS
Customers
Connections
OPERATIONS
Faults
Maintenance
Calendar
REPORTS
Reports
ADMINISTRATION
Staff Management
System Administrator

Felix Akello
KP-2026-0007

+254456852357
Akello@gmail.com
389653
Nairobi West, Nairobi, Nairobi

Type: Residential
Status: Active
Registered: Jan 23, 2026

Connections
+ Add Connection

Meter No.	Type	Capacity	Status	Actions
No connections found				

Recent Service Requests

ID	Type	Status	Date
No service requests			

Figure 3: New Customer Created

5. Observe the auto-generated account number (format: KP-2026-XXXX)

6. Navigate to Connections > Add Connection for the new customer

Kenya Power

Dashboard
CUSTOMERS
Customers
Connections
OPERATIONS
Faults
Maintenance
Calendar
REPORTS
Reports
ADMINISTRATION
Staff Management
System Administrator

Add New Connection
← Back

Customer *
KP-2026-0007 - Felix Akello

County Code (for Meter No.)
Nairobi (NAI)

Connection Type *
Single Phase

Load Capacity (kVA) *
5.00

Installation Date
23/01/2026

Transformer ID
TRF-NI-067

Feeder Line
FDR-NI-A6

GPS Coordinates
-1.2921,36.8219

Initial Status
Active

Create Connection Cancel

Figure 4: Application for connection for new customer

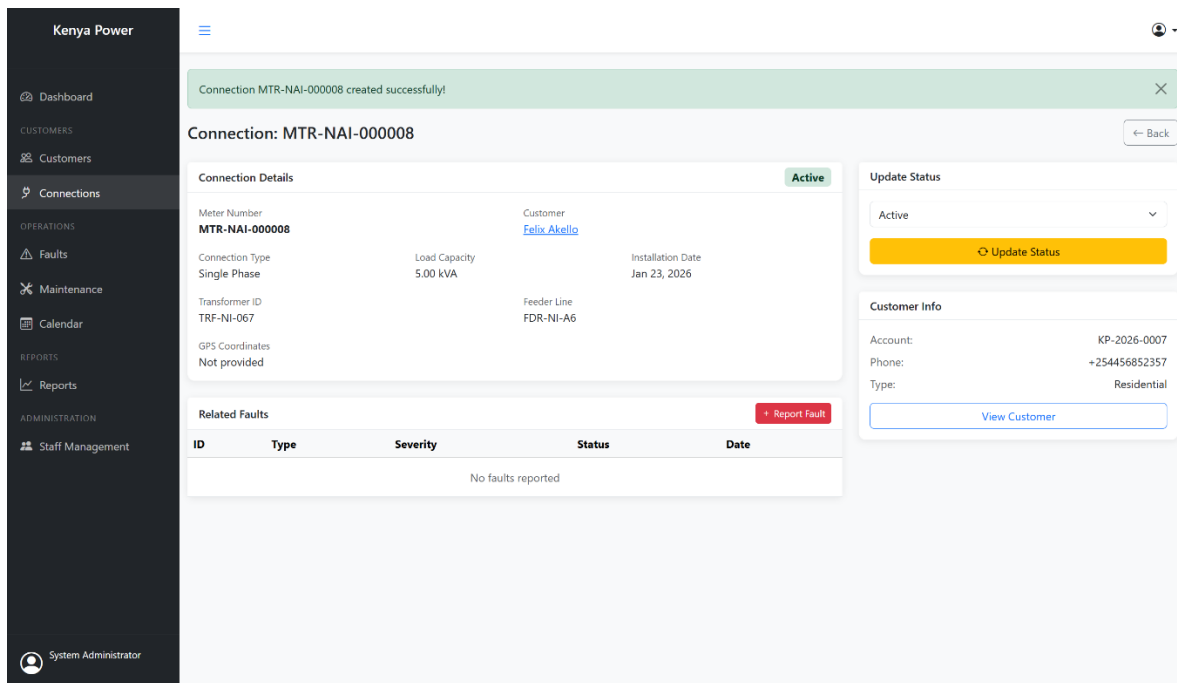


Figure 5: Coonnection for customer created

7. Observe the auto-generated meter number (format: MTR-XXX-NNNNNN)
8. Demonstrate status lifecycle: pending > active > suspended > disconnected

5.2 Fault Reporting and Resolution

OBJECTIVE: Enable fault reporting, log repair requests, track resolution process, and ensure timely repairs.

Requirement	Status	Implementation
Report faults	MET	Staff: /faults/report, Customer: /portal/faults/report
Log repair requests	MET	FaultUpdate model tracks all changes
Track resolution	MET	6-stage workflow: reported → resolved → closed
Timely repairs	MET	Resolution time calculation, technician notifications

HOW TO PROVE THIS OBJECTIVE IS MET:

9. Login as customer service agent (cs_agent1 / password123) or as any customer

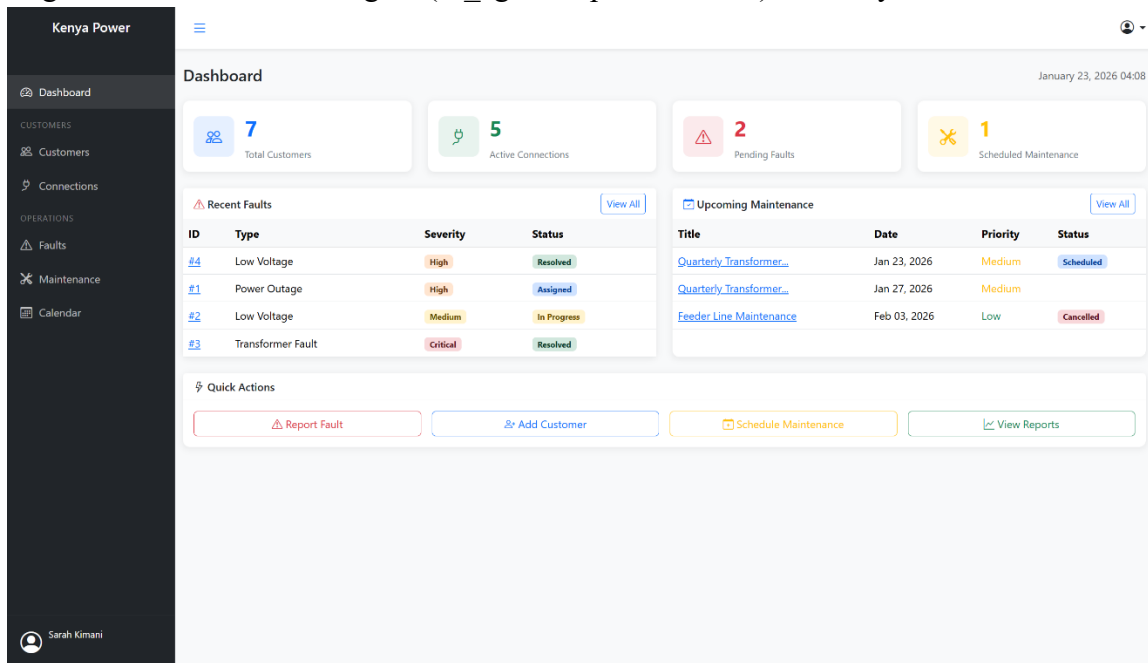


Figure 6: Customer service agent dashboard

10. Navigate to Faults > Report Fault and submit a new fault

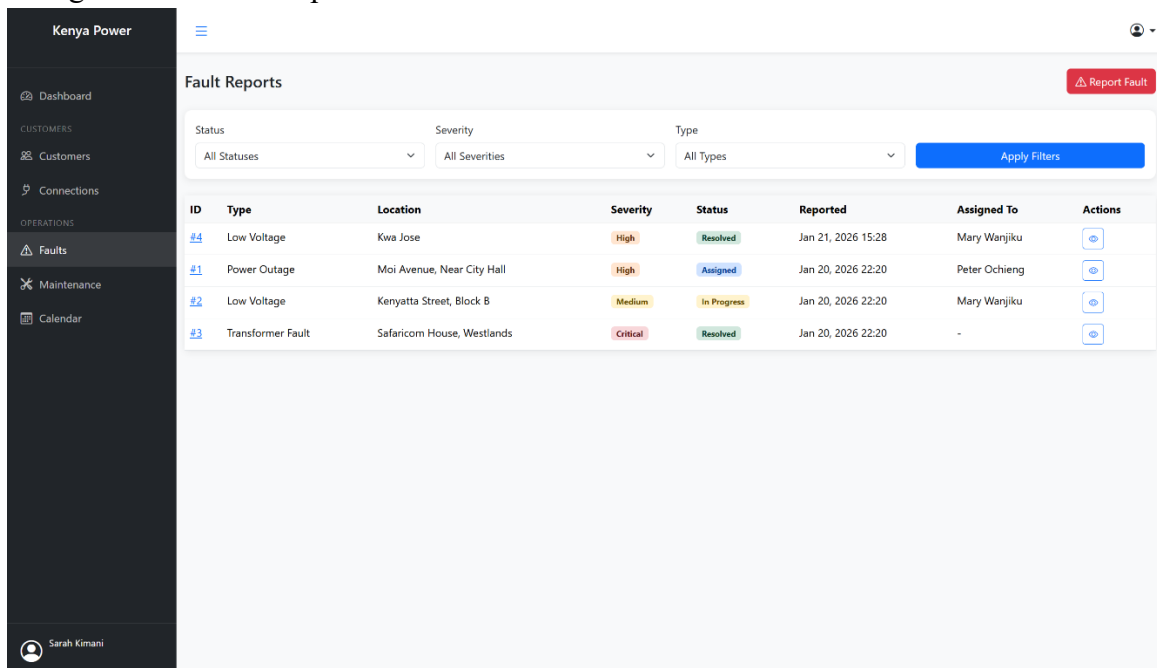


Figure 7: Fault dashboard

The screenshot displays the 'Fault #5' page in the Kenya Power application. The left sidebar shows the navigation menu with 'Faults' selected. The main content area is titled 'Fault #5' and includes a 'Reported' status tag. The 'Fault Details' section shows: Fault Type: Power Outage, Severity: High, Description: Test fault, Location: Nairobi, GPS Coordinates: Not provided, Reported Date: Jan 23, 2026 at 01:20, Affected Customers: 1, and Related Meter: MTR-NAI-000002. The 'Update Status' section has a 'New Status' dropdown set to 'Reported' and an 'Update Status' button. The 'Update History' section shows 'No updates yet'. The 'Add Note' section has a text input field and an 'Add Note' button. The 'Quick Info' section shows Fault ID: #5 and Reported: Jan 23, 2026. The user profile at the bottom left is Sarah Kimani.

Figure 8: New Fault created

11. Login as manager (manager1 / password123) and assign fault to technician

The screenshot displays the 'Fault #5' page in the Kenya Power application, now assigned to a technician. The left sidebar shows the navigation menu with 'Faults' selected. The main content area is titled 'Fault #5' and includes an 'Assigned' status tag. The 'Fault Details' section shows the same information as Figure 8. A green banner at the top of the details section says 'Resolved: Jan 23, 2026 at 01:25'. The 'Update History' section shows two entries: 'Assignment' (Jan 23, 2026 at 01:55 by James Mwangi, Assigned to technician ID: 3, Status changed: resolved -> assigned) and 'Status Change' (Jan 23, 2026 at 01:25 by Peter Ochieng Status changed: reported -> resolved). The 'Assignment' section shows 'Currently Assigned: Peter Ochieng' and an 'Assign to Technician' dropdown set to 'Peter Ochieng', with an 'Assign' button. The 'Update Status' section has a 'New Status' dropdown set to 'Assigned' and an 'Update Status' button. The 'Quick Info' section shows Fault ID: #5, Reported: Jan 23, 2026, and Assigned: Jan 23, 2026. The user profile at the bottom left is James Mwangi.

Figure 9: Fault assigned to technician by manager

12. Login as technician (tech1 / password123) and update status to "Resolved"

The screenshot displays the 'Fault #5' details page in the Kenya Power application. The left sidebar shows navigation options: Dashboard, CUSTOMERS (Customers, Connections), OPERATIONS (Faults, Maintenance, Calendar), and a user profile for Peter Ochieng. The main content area is titled 'Fault #5' and includes a 'Back to Faults' link. The 'Fault Details' section shows the fault type as 'Power Outage' with a 'High' severity, description 'Test fault', location 'Nairobi', and related meter 'MTR-NAI-000002'. The 'Update Status' section has a dropdown menu set to 'Assigned' and a yellow 'Update Status' button. The 'Update History' section shows two entries: 'Assignment' (Jan 23, 2026 at 01:55 by James Mwangi) and 'Status Change' (Jan 23, 2026 at 01:25 by Peter Ochieng). The 'Quick Info' section shows the fault ID as #5, reported on Jan 23, 2026, assigned on Jan 23, 2026, with a resolution time of 0.1 hours. An 'Add Note' section is at the bottom with a text input field and an 'Add Note' button.

Figure 10: Fault status updated by assigned technician

13. View fault details showing resolution time calculation

5.3 Maintenance Scheduling

Requirement	Status	Implementation
Preventive maintenance	MET	MaintenanceSchedule model with type="preventive"
Distribution lines	MET	equipment_type: feeder_line, transformer, etc.
Reduce outage risk	MET	Calendar view, priority levels, assignments

5.4 Performance Reporting

Requirement	Status	Implementation
Maintenance reports	MET	/reports/maintenance with completion rates
Fault resolution times	MET	/reports/faults with avg resolution calculation
Performance metrics	MET	/reports/performance with KPI dashboard
Visual representations	MET	Chart.js: doughnut, bar, line charts

6. Default Credentials & Quick Reference

6.1 Staff Login Credentials

Role	Username	Password	Access Level
Administrator	admin	Password123	Full system access
Manager	manager1	password123	Operations + Reports
Technician	tech1	password123	Assigned work only
Technician 2	tech2	password123	Assigned work only
Customer Service	cs_agent1	password123	Customer management

6.2 Application URLs

Function	URL
Landing Page	http://127.0.0.1:5000/
Staff Login	http://127.0.0.1:5000/login
Staff Dashboard	http://127.0.0.1:5000/dashboard
Customer Portal Login	http://127.0.0.1:5000/portal/login
Customer Registration	http://127.0.0.1:5000/portal/register
Reports Dashboard	http://127.0.0.1:5000/reports/

6.3 Quick Start Guide

14. **Initialize Database:** `python init_db.py`
15. **Start Application:** `python run.py`
16. **Access Application:** Open browser to `http://127.0.0.1:5000/`
17. **Login as Admin:** Username: admin / Password: admin123

6.4 Demonstration Checklist

- Start application: `python run.py`
- Login as admin to show full access
- Create a customer (observe auto-generated account number)
- Create a connection (observe auto-generated meter number)

- Report a fault and assign to technician
- Schedule maintenance and view calendar
- View reports and charts
- Login as different roles to show access restrictions
- Access customer portal to demonstrate self-service features

This documentation was prepared for academic assessment purposes.

Kenya Power Electrical Systems Management Application

Comprehensive Project Documentation & User Guide