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DBMS PROJECT REPORT

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COURSE: B.Sc. ELECTRONIC AND COMPUTER ENGINEERING

ICS 2206

INTRODUCTION TO DATABASE MANAGEMENT SYSTEMS

TITLE: KENYA POWER ELECTRICAL SYSTEMS MANAGEMENT APPLICATION

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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

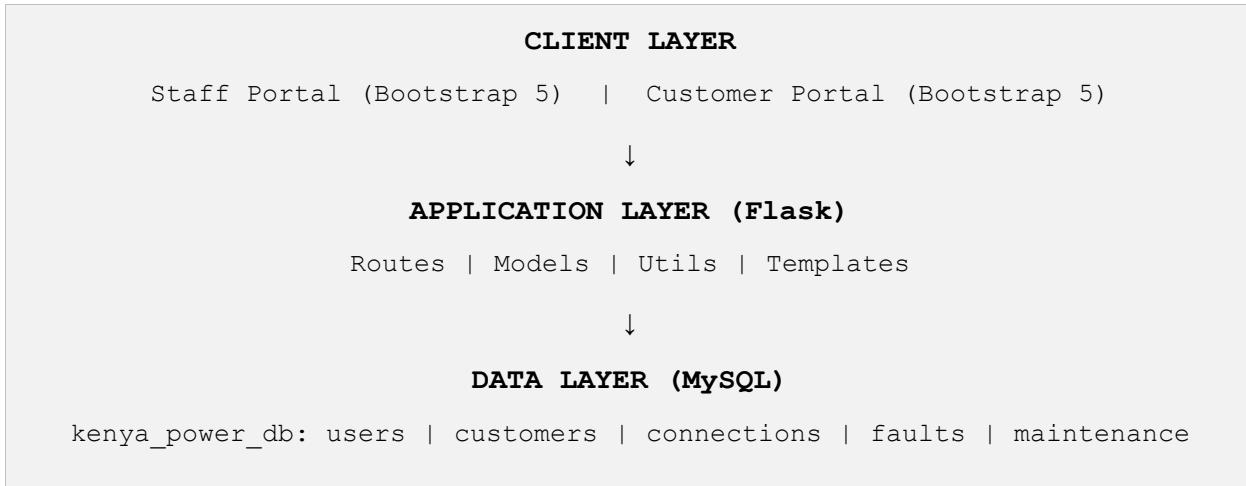
1.3 Technology Stack

| 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 |
| faults_bp | /faults | 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:

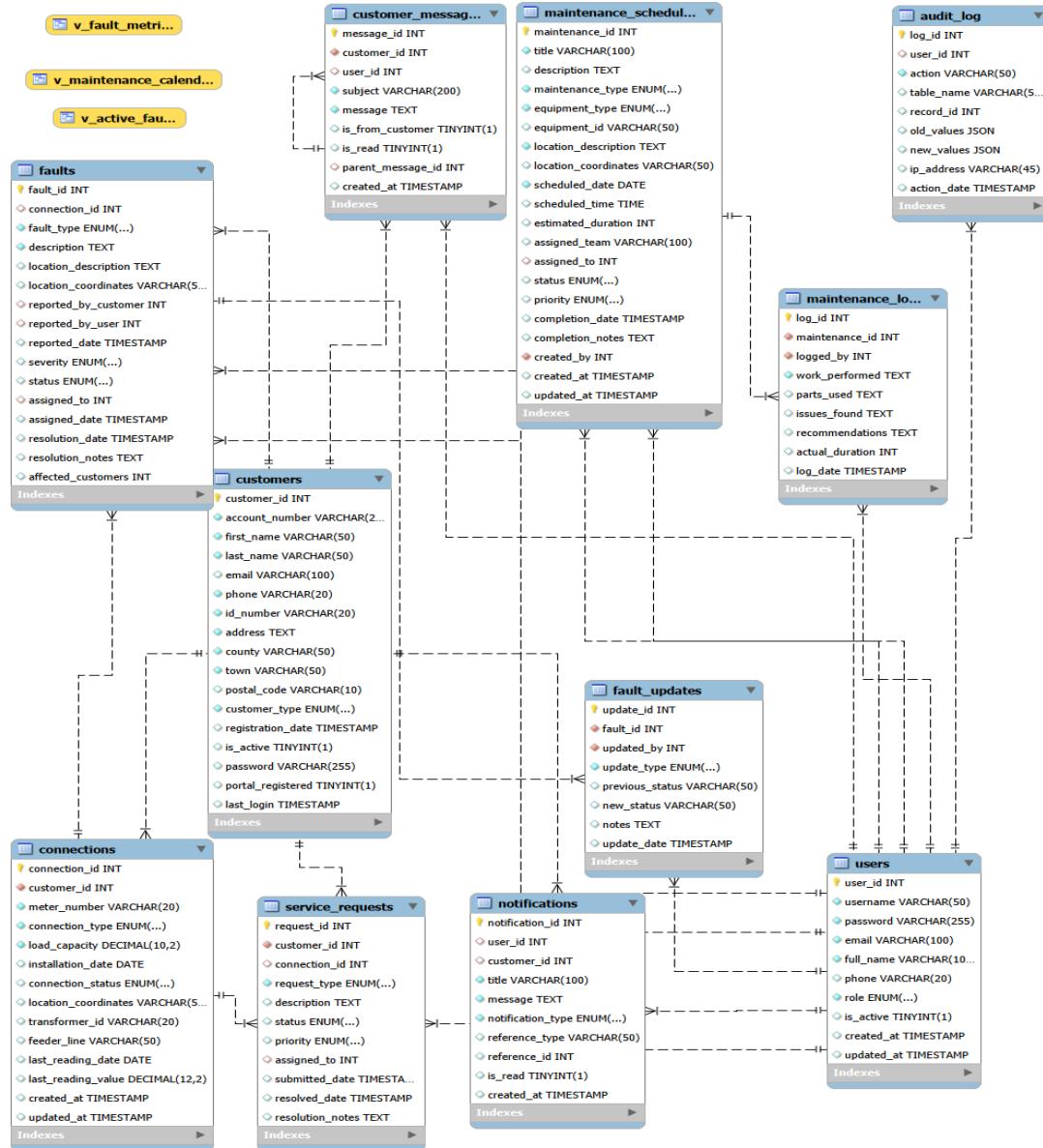


Figure 1: Entity-Relationship Diagram

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

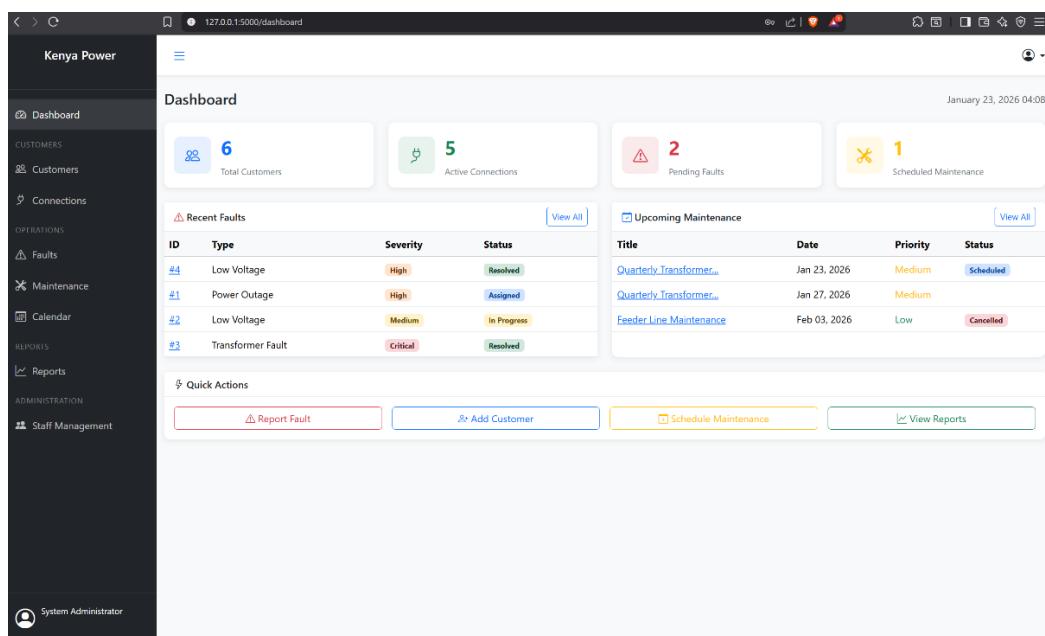


Figure 2: System Administrator's Dashboard

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

The screenshot shows the 'Customer Information' section for a new customer named 'Felix Akello'. The profile includes a placeholder user icon, the name 'Felix Akello', and account number 'KP-2026-0007'. Below the name are contact details: phone (+254456852357), email (Akello@gmail.com), and address (389655, Nairobi West, Nairobi, Nairobi). The customer is categorized as 'Residential' and 'Active', registered on Jan 23, 2026. To the right, there are sections for 'Connections' (empty) and 'Recent Service Requests' (empty).

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

The screenshot shows the 'Add New Connection' form. It requires selecting a 'Customer' (set to 'KP-2026-0007 - Felix Akello') and a 'County Code (for Meter No.)' (set to 'Nairobi (NAI)'). Other fields include 'Connection Type' (set to 'Single Phase'), 'Load Capacity (kVA)' (set to '5.00'), 'Installation Date' (set to '23/01/2026'), 'Transformer ID' (set to 'TRF-NI-067'), 'Feeder Line' (set to 'FDR-NI-A6'), 'GPS Coordinates' (set to '-1.2921,36.8219'), and 'Initial Status' (set to 'Active'). At the bottom are 'Create Connection' and 'Cancel' buttons.

Figure 4: Application for connection for new customer

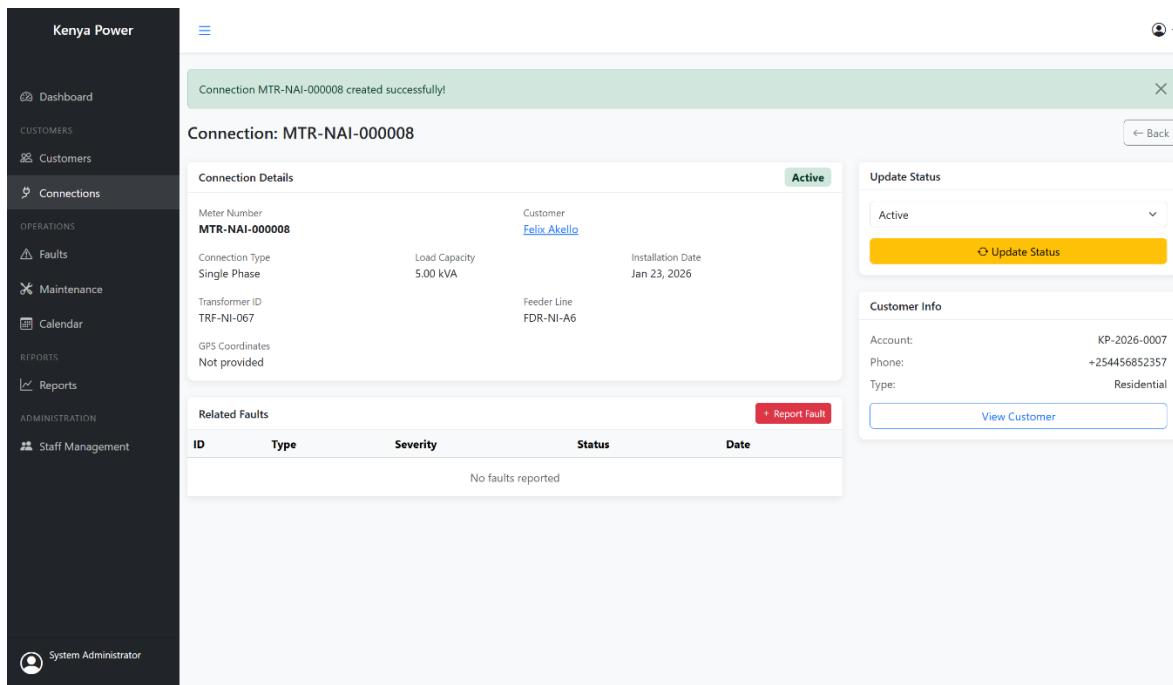


Figure 5: Coonection for customer created

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

The dashboard displays the following key metrics:

- Total Customers: 7
- Active Connections: 5
- Pending Faults: 2
- Scheduled Maintenance: 1

Recent Faults:

| ID | Type | Severity | Status |
|----|-------------------|----------|-------------|
| #4 | Low Voltage | High | Resolved |
| #1 | Power Outage | High | Assigned |
| #2 | Low Voltage | Medium | In Progress |
| #3 | Transformer Fault | Critical | Resolved |

Upcoming Maintenance:

| Title | Date | Priority | Status |
|--------------------------|--------------|----------|-----------|
| Quarterly Transformer... | Jan 23, 2026 | Medium | Scheduled |
| Quarterly Transformer... | Jan 27, 2026 | Medium | Planned |
| Feeder Line Maintenance | Feb 03, 2026 | Low | Cancelled |

Quick Actions:

- Report Fault
- Add Customer
- Schedule Maintenance
- View Reports

Figure 6: Customer service agent dashboard

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

The dashboard shows a list of reported faults with the following details:

| ID | Type | Location | Severity | Status | Reported | Assigned To | Actions |
|----|-------------------|----------------------------|----------|-------------|--------------------|---------------|---------|
| #4 | Low Voltage | Kwa Jose | High | Resolved | Jan 21, 2026 15:28 | Mary Wanjiku | |
| #1 | Power Outage | Moi Avenue, Near City Hall | High | Assigned | Jan 20, 2026 22:20 | Peter Ochieng | |
| #2 | Low Voltage | Kenyatta Street, Block B | Medium | In Progress | Jan 20, 2026 22:20 | Mary Wanjiku | |
| #3 | Transformer Fault | Safaricom House, Westlands | Critical | Resolved | Jan 20, 2026 22:20 | - | |

Fault Reports:

Filters available:

- Status: All Statuses
- Severity: All Severities
- Type: All Types

Buttons:

- Report Fault
- Apply Filters

Figure 7: Fault dashboard

The screenshot shows the 'Fault #5' creation page. The left sidebar includes 'Dashboard', 'CUSTOMERS', 'Connections', 'OPERATIONS', 'Faults' (selected), 'Maintenance', and 'Calendar'. The top right has a 'Back to Faults' link. The main area shows 'Fault Details' for a 'Power Outage' at 'Test fault' location 'Nairobi' on 'Jan 23, 2026 at 01:20'. The 'Severity' is 'High'. A 'Reported' button is shown. To the right is an 'Update Status' section with dropdowns for 'New Status' (set to 'Reported') and 'Notes' (optional notes). A yellow 'Update Status' button is at the bottom. Below it is a 'Quick Info' section with 'Fault ID: #5' and 'Reported: Jan 23, 2026'. On the left, there's an 'Add Note' section with a note input field and a blue 'Add Note' button. The bottom left shows a user profile for 'Sarah Kimani'.

Figure 8: New Fault created

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

The screenshot shows the 'Fault #5' page after assignment. The left sidebar and top right are identical to Figure 8. The main area shows the fault details and a green success message 'Fault assigned successfully!'. The 'Status' is now 'Assigned'. The 'Assignment' section shows 'Currently Assigned: Peter Ochieng' and an 'Assign to Technician' dropdown set to 'Peter Ochieng'. A large blue 'Assign' button is present. The 'Update Status' section shows 'New Status: Assigned'. The 'Quick Info' section remains the same. The bottom left shows a user profile for 'James Mwangi'.

Figure 9: Fault assigned to technician by manager

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

The screenshot shows the Kenya Power Electrical Systems Management Application interface. On the left is a dark sidebar with navigation links: Dashboard, CUSTOMERS (Customers, Connections), OPERATIONS (Faults, Maintenance, Calendar). The main content area is titled 'Fault #5'. It displays 'Fault Details' including Fault Type (Power Outage, Severity High), Description (Test fault), Location (Nairobi), Reported Date (Jan 23, 2026 at 01:20), Affected Customers (1), and Related Meter (MTR-NAI-000002). A 'Update Status' section on the right shows the status being changed from 'Assigned' to 'Resolved'. A 'Quick Info' box provides summary details: Fault ID #5, Reported Jan 23, 2026, Assigned Jan 23, 2026, Resolution Time 0.1 hours. The 'Update History' section shows two entries: 'Assignment' (assigned to technician ID: 3, status changed from resolved to assigned) and 'Status Change' (status changed from reported to resolved). An 'Add Note' section at the bottom allows for additional comments.

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
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This documentation was prepared for academic assessment purposes.

Kenya Power Electrical Systems Management Application

Comprehensive Project Documentation & User Guide