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| **UNIVERSITY OF NAIROBI**  **FACULTY OF ENGINEERING**  **DEPARTMENT OF ELECTRICAL & INFORMATION ENGINEERING** |
| **Design and Implementation of a Solar-Powered Smart Microgrid for Rural Electrification in Kenya** |
|  |
| **MSc Thesis** |
|  |
| **STUDENT NAME** |
| **BSc Electrical Eng (University of Nairobi)** |
| **FEE6/12345/2025** |
| **A thesis submitted in partial fulfilment of the requirements for the award of the Degree of Master of Science in Electrical & Electronic Engineering of the University of Nairobi** |
| **JULY 2025** |

Template updated: 2025-07-28

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DECLARATION AND APPROVAL

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| This thesis is my original work. I also affirm that to the best of my knowledge; this has not been presented for a degree in any other university. | | | | | |
| Name: **Student Name** | | | [studentname@students.uonbi.ac.ke](mailto:studentname@students.uonbi.ac.ke) | | |
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| This thesis is submitted for examination with our approval and knowledge as university supervisors: | | | | | |
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**UNIVERSITY OF NAIROBI**

DECLARATION OF ORIGINALITY

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| Student Name: | | Student Name | | | | |
| Registration Number: | | FEE6/12345/2025 | | | | |
| Faculty/School/Institute: | | Faculty of Engineering | | | | |
| Department: | | Department of Electrical & Information Engineering | | | | |
| Course Name: | | Master of Science in Electrical & Electronic Engineering | | | | |
| Title of Work: | | Design and Implementation of a Solar-Powered Smart Microgrid for Rural Electrification in Kenya | | | | |
|  | | | | | | |
| 1. I understand what plagiarism is, and I am aware of the university policy in this regard. 2. I declare that this thesis is my original work and has not been submitted elsewhere for examination, the award of a degree or publication. Where other works or my own work has been used, this has properly been acknowledged and referenced in accordance with the University of Nairobi’s requirements. 3. I have not sought or used the services of any professional agencies to produce this work. 4. I have not allowed and shall not allow anyone to copy my work to pass it off as his/her work. 5. I understand that any false claim in respect of this work shall result in disciplinary action in accordance with University of Nairobi anti-plagiarism policy. | | | | | | |
| Signature: | …………………………... | |  | Date: | ………………………... |  |

DEDICATION

The student may make a dedication of their thesis to parents, family, friends, historical figures, or religious being/s.

ACKNOWLEDGEMENT

It is required to acknowledge any assistance rendered during the study on page. Supervisors should be acknowledged first. Supervisors should be acknowledged in their role as supervisor. Use active language.

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Charts, Images, graphs, illustrations, photographs and plates should be in the List of Figures. There should be no separate lists for each.

List of Figures should start on its own page.

ABBREVIATIONS & ACRONYMS

Should start on its own page.

|  |  |
| --- | --- |
| **Item** | **Meaning** |
| CFRP | Carbon Fibre Reinforced Polymer |
| CPD | Continuous Professional Development |
| CUE | Commission for University Education |
| EBK | Engineers Board of Kenya |
| IStructE | Institution of Structural Engineers |
| KEBS | Kenya Bureau of Standards |
| KMD | Kenya Meteorological Department |
| NCA | National Construction Agency |
| PDU | Professional Development Unit |
| PIP | Professional Interview Preparation |
| TAHMO | Trans-African Hydrometeorological Organisation |

Abbreviations should be arranged in alphabetical order. There should be no hyphen in between words. Use tables to format then hide the borders.

ABSTRACT

It shall be short and concise. It should be a maximum of 1 page and in one paragraph. The contents should include what is the issue, what will be studied (objectives) and how it will be done (methodology). The ‘Abstract’ appears just before the ‘Introduction’; although unusual, this placement of the abstract is the University standard.

**Notes to the Template**

Please note this template is only for guidance and you should adhere to your supervisor’s advice. The initial pages take advantage of tables for formatting. To edit the first pages, highlight the table and turn the borders on to see the table lines. Take advantage of the ‘Styles’ palette in the ‘Home’ ribbon of Microsoft Office to format this thesis template document.

For the subsequent chapters, please note the heading title must first be centre-aligned and written in words ‘CHAPTER ONE’ and not ‘CHAPTER 1’. The numbered headings (with Arabic numerals) should be left-aligned. The paragraph text throughout should be justified (both left and right-aligned) even though APA requirements state that the text should be left-aligned with the right side being jagged.

CHAPTER ONE

# INTRODUCTION

## Background of the Study

This section provides a brief overview of the area of study. It should inform the reader what the study was about and why it was important and timely (McKenzie, 2013). The last paragraph should state in general what the study did to address the issue. The background should not exceed two pages and should not include details such as tables, figures or lists. The headings should be left aligned.

## Problem Statement

This section should recap the background information identifying the gaps in knowledge or problems to be addressed in the study. The statement should be concise and presented in one paragraph not exceeding one page. It should end with a statement of therefore what had to be done to address the problem.

## Research Objectives

Objectives should be to fill the gap in knowledge highlighted in the Background Information and the Problem Statement by creating an understanding of the issue, and not a set of activities. The “Overall” or “General” objective should be stated first followed by specific objectives.

There should be at least three specific objectives. All objectives should be deductive. Use terms such as ‘characterise, ‘evaluate’, ‘establish’, and ‘compare’. Do not use terms that are mere tasks such as ‘determine’, ‘assess’ and ‘identify’ or vague such as investigate or study.

## Scope and Limitations of the Study

Scope of work indicates the depth of research; how deep/far the study will be involved in the subject area, which geographical area, source of material, where testing will take place. Clear study boundaries (limits) should be included as well as study variables.

## Definition of terms (If necessary)

**Smart Microgrid**: A decentralized energy system that integrates renewable generation (e.g., solar PV), energy storage (e.g., batteries), and intelligent control mechanisms (e.g., IoT sensors, machine learning algorithms) to optimize power distribution autonomously. Unlike traditional grids, smart microgrids can operate in both grid-connected and islanded modes, enabling resilience and efficiency in rural electrification (Bhattacharya & Roy, 2022).

In summary, **Chapter 1 - Introduction** should have the following information under the relevant subheadings as earlier presented:

1. Background information
2. What is the issue or problem?
3. What are the objectives of the study?
4. What is the significance/justification of the study?
5. How do you plan to deal with the problem?
6. What is your expected solution/suggestion/intervention?

CHAPTER TWO

# LITERATURE REVIEW

## Introductions

This section shall present information on the evolution and present state of theory, practice and research of the topic proposed for investigation. A candidate is expected to demonstrate review of most recent and relevant publications which must be properly cited in the references. This section may be organized with subheadings to represent different areas of emphasis. Reference in text should be cited as follows: These results are similar to those that were found by Wismer and Luth (1973). It was also seen by Kepner *et al.* (1972). It is believed the approach took effect from the mid 1900s (Odo *et al.*, 1999; Wire, 2001; Luti, 2010). Or if information is obtained from the website, then the url address and date of access should be included ([www.ojose.com](http://www.ojose.com), accessed on 12th December 2011).

Figures should be centred and figure caption placed below the figure as shown in Figure 2.1. Figures should be numbered according to the chapter

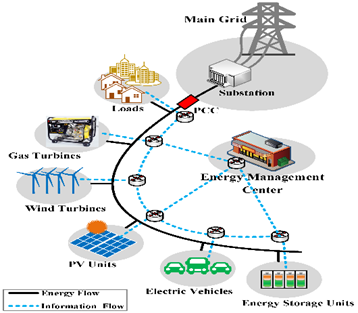


Figure .: Smart microgrid

Equations should be aligned to the left and equation number aligned to the right. All equations should be numbered systematically throughout with the first figure referencing the chapter and the second the serial number of the equation. Equation 2.1 was developed by Otieno et al. (2023) for microgrids in Sub-Saharan Africa:

(2.1)

Table title and number should be put above the table as shown in Table 2.1.

Table .: Types of remote sensing sensors.

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## (Last section) Implication/Synthesis of Literature Review/Knowledge Gaps

Include knowledge gaps.

In summary, **Chapter 2 – Literature Review** should have the following information under the relevant subheadings as earlier presented:

1. What is the current thinking, findings, and approaches on the problem/issue?
2. How does the literature motivate your research issues?
3. What is the way forward?

CHAPTER THREE

# METHODOLOGY

Briefly but accurately explains how you performed your research in a logically organized manner. This section should be sufficiently detailed to allow the reader to duplicate the important aspects of your methods. It is quite common for this section to contain labelled subsections dealing with apparatus, materials and specific procedures used. It establishes the credibility of your methodology or the lack of it. Commercially available pieces of apparatus may be described in terms of their commercial labels while specially constructed apparatus needs to be described in greater details. Highlights of the expected outputs should also be given.

## Overview of Methodology

Provide an overview of the procedures.

## Description of Study area (If descriptive)

Provide description of study area including location maps and coordinates.

## Steps

Provide the steps in the methodology.

In summary, **Chapter 3 – Methodology/Materials & Methods** should have the following information under the relevant subheadings as earlier presented:

1. What procedures were used in collection of information or data on the topic of research?
2. What special steps did the researcher take to select or utilize the data?
3. Ethical considerations and confidentiality?
4. What is the researcher’s impression of the utility, relevance, or quality of the data collected?
5. How is the analysis planned using relevant tools?

CHAPTER FOUR

# RESULTS & DISCUSSION

## Results

This section basically describes ‘what happened’ in the investigation. There are several approaches to writing this section.

1. Presentation of results without analysis.
2. Presentation of results with limited interpretation.
3. Combination of results and discussion.

Use of figures and tables: Results are normally presented in Tables and Figures. All tables and figures must be referenced in the text. Their formats should conform to the APA 7th Edition. A candidate may be required to use statistical methods wherever applicable.

## Discussion

In this section, the question to be answered is ‘what do my results mean and what are their implications? This is the most thoughtful and demanding section. The section has three parts: facts found, commentary on the facts and theoretical implications of the facts. These will operate together and constantly interact in the discussion. The ultimate goal is to interpret the results for the readers so that they understand their meaning. Clear relations must be drawn to previous work done by other researchers. Explanations on why things happened or did not happen should be provided.

The thesis may include other sections and sub-sections such as validation of the results and so on.

In summary, **Chapter 4 – Results & Discussion** should have the following information under the relevant subheadings as earlier presented:

1. What are the research findings?
2. Are there problems with the findings in terms of answering the questions posed in the introduction?
3. Summarize the most important findings?
4. What do your findings mean/imply?
5. What conclusions can you draw?
6. How do your results fit into a broader context of the subject and how do they compare with previous findings?

CHAPTER FIVE

# CONCLUSIONS & RECOMMENDATIONS

## Conclusions

The findings of the study are restated precisely and brief. The conclusions are typically given in numbered bullets after an introductory sentence. The number of conclusions should match the number of specific objectives.

## Recommendations

### Recommendations from this Study

Recommendations to be applied from the study are provided. The recommendations are typically given in numbered bullets after an introductory sentence.

### Recommendation for further Study

Recommendations for further studies are provided. The recommendations are typically given in numbered bullets after an introductory sentence. It enhances continuity of the research.

In summary, **Chapter 5 – Conclusions & Recommendations** should have the following information under the relevant subheadings as earlier presented:

1. Indicate the conclusions on the basis of analysis conducted.
2. What are the implications of the findings and provide recommendations?
3. What are the recommendations/solutions/way forward?
4. Mention the areas of further study.

REFERENCES

The references are not a chapter, and it should therefore not be numbered. The method of citing the studies include the authors’ names and the year of publication of cited literature are used in the text, in citing the literature, thus: “These results are similar to those that were found by Wismer *et al.* (1973) and by Kepner *et al.* (1972)”. In the references section, the cited references are then listed, without numbering but in proper alphabetical order, as shown below:

**Articles in journals**

Benediktsson J. A. and I. Kanellopoulos (1999). Classification of Multisource and Hyperspectral Data Based on Decision Fusion, *IEEE Transactions on Geosciense and Remote Sensing,* 37(3): 1367-1377.

**Reports**

Craglia, M. and A. Annoni (2003). *The Spatial Impact of European Union Policies*, EUR 20121 EN, Ispra: European Communities.

**Chapters in Edited Volumes**

Licklider J.C.R. (1960). "Quasi–linear operator models in the study of manual tracking", in Duncan R. L. (Ed). *Developments in Mathematical Psychology: Information, Learning, and Tracking*. Glencoe, Ill.: Free Press, pp. 167–279.

**Web-based articles**

Peterson R.E. (1997). Eight Internet Search Engines Compared, *First Monday,* 2(2) (February), at http://firstmonday.org/issues/issue2\_2/peterson/, [accessed 14 December 2001].

**Proceedings**

Riecken, J., Bernard, L., Portele, C. and A. Remke (2003). “North-Rhine Westphalia: Building a Regional SDI in a Cross-Border Environment / Ad-Hoc Integration of SDIs: Lessons learnt”, *Proceedings 9th EC-GI & GIS Workshop ESDI, June 25-27 2003, Coruña, Spain,* pp. 13-56. Ispra: European Communities.

**Books**

Soille, P. (1999). *Morphological Image Analysis - Principles and Applications*, Berlin: Springer Verlag.

**Sample List of References below:**

Arduini, M., Tommaso, A. D., Manfroni, O., Ferrari, S., & Romagnolo, M. (1999). The passive confinement of elements compressed in concrete with sheets of composite material. *The Italian Cement Industry*, *69*(748), 836–841.

Associated Press. (2019, December 6). *Building collapses in Kenya, unknown number trapped in debris*. South China Morning Post. https://www.scmp.com/news/world/africa/ article/3040999/six-floor-building-collapses-nairobi-kenya-unknown-number-trapped

Bank, L. C. (2006). Application of FRP Composites to Bridges in the USA. *International Colloquium on Application of FRP to Bridges*, 9–16. https://www.researchgate.net/ publication/234094998\_Application\_of\_FRP\_Composites\_to\_Bridges\_in\_the\_USA

BSI. (2009). *BS EN 12390-2:2009—Testing Hardened Concrete*. British Standards Institute.

BSI. (2012). *BS EN 12390-1:2012—Testing Hardened Concrete. Shape, dimensions and other requirements for specimens and moulds.* British Standards Institute.

CEN. (2004). *EN 1992-1-1:2004—Eurocode 2: Design of concrete structures—Part 1-1: General rules and rules for buildings*. European Committee for Standardization.

Fekete, J. R., & Hall, J. N. (2017). Design of auto body: Materials perspective. In *Automotive Steels* (pp. 1–18).

Horse Construction. (2019, December 23). *Carbon Fibre Wrap for Concrete Columns Strengthening*. https://www.horseen.com/index/solution/content/id/498

IQSK. (2019). *Building Construction Cost Handbook—2018/2019* (Handbook 2018/2019). Institute of Quantity Surveyors of Kenya.

Jaya, K. P., & Mathai, J. (2012). *Strengthening of RC Column using GFRP and CFRP*. *1 of 38*. http://toc.proceedings.com/24574webtoc.pdf

APPENDICES

The appendices should be clearly labelled and placed after the reference section. The labelling system should be e.g. Appendix A (A.1, A.2 …), Appendix B (B.1, B.2), etc. They should be listed in the Table of Contents.

* 1. MATLAB/PYTHON CODES

Codes.

**Additional Information for the Proposal:**

1. **Each Chapter should always start on a new page.**
2. **Required Font, Times New Roman, Font Size 12, Double spacing.**
3. **CUE guidelines approximate an MSc Thesis should have 20 000 – 30 000 words while a PhD Thesis should have 40 000 – 50 000 words.**
4. **Refer to the APA 7th Edition Manual for more comprehensive guidelines.**