

**Department of Electrical and Computer Engineering
North South University**



Senior Design Project Report

DISTRIBUTED & LUMPED CIRCUIT MODELLING

**Oshin Mumtaha #1821191043
Ummey Honey Supty #1831144643
Rakib Ahamed #1831685043**

B.Sc., North South University, Dhaka, 2022

**Faculty Advisor
Dr. Nafisa Noor
ECE Department
Fall 2022**

DECLARATION

This serves as an assurance that this Project is our unique creation. Each member who worked on this project has an equal contribution. No portion of this work has ever been partially or totally submitted elsewhere for the award of another degree or diploma. Every piece of content that was copied for this project has been appropriately acknowledged.

Student's Name and Signature

Oshin Mumtaha

Oshin

Ummey Honey Supty

Supty

Rakib Ahamed

Rakib

APPROVAL PAGE
DISTRIBUTED & LUMPED CIRCUIT MODELLING

Presented by

Oshin Mumtaha, B.Sc. Engr.
Ummey Honey Supty, B.Sc. Engr.
Rakib Ahamed, B.Sc. Engr.

Major Advisor _____
Dr. Nafisa Noor

Department Chair _____
Dr. Rajesh Palit

North South University

2022

ACKNOWLEDGEMENTS

First of all, we would thank the Almighty for providing us the capability to carry out our tasks and finish the report. Our faculty advisor, Dr. Nafisa Noor, who successfully guided us throughout CSE/EEE499A and CSE/EEE499B in our senior design project, deserves special recognition. Her direction was really helpful to us in all of our research, writing, and project completion. Our sincere thanks also go to North South University, Dhaka, Bangladesh for giving us such a platform where we can have an industrial-level experience as a part of our academics. Last but not the least, we would like to thank our family as their inspiration and guidance kept us focused and motivated.

Contents

| | | |
|----------|--|-----------|
| 1 | Background Studies | 7 |
| 2 | Crossbar Architecture | 8 |
| | 2.1 Word/Bit Lines: | 8 |
| | 2.2 Array: | 9 |
| | 2.3 Biasing: | 10 |
| | 2.4 Junctions: | 11 |
| | 2.5 Diode: | 12 |
| | 2.6 Application: | 13 |
| 3 | Memristor..... | 14 |
| | 3.1 Resistive Switching Memory Device | 14 |
| | 3.2 Phase Change Memory (PCM)..... | 15 |
| 4 | Circuit Components | 17 |
| | 4.1 Parasitic Components | 17 |
| | 4.2 Capacitances | 17 |
| | 4.3 Resistances..... | 19 |
| 5 | Lumped Equivalent Circuit Modelling | 21 |
| | 5.1 Unit Cells..... | 21 |
| | 5.2 Distributed Parameter Simulation..... | 22 |
| 6 | Results and Discussions..... | 24 |
| | 6.1 Continuous Current Vs Time | 24 |
| | 6.2 Percentage Change in Delay | 25 |
| | 6.3 Graphical Plots..... | 26 |
| 7 | Conclusion | 27 |
| 8 | Reference | 28 |

DISTRIBUTED & LUMPED CIRCUIT MODELLING

ABSTRACT

Erasable physical unclonable function (PUF) with memristor crossbar array is one of the dense research sectors in the field of nanotechnology. The traditional way of designing PUFs is done by focusing on the variation of CMOS (Complementary Metal Oxide Semiconductor) technology. In recent times, with the advancement of nanotechnology in nanoelectronic devices such as memristors which can be used for more efficient outcomes.

Our paper is concentrated on the delay caused by crossbar array using memristor. Our prime goal is to max out the delay for achieving a slower read-out time. This will resist any outsider to break into the system due to the longer time period. In the present time, we are utilizing the power of electronic devices more than ever. It has become a portion of our daily life. Thus, the protection of private data needs to be ensured. The PUF is dependent upon the cell-to-cell resistance with the alteration of the memristor cells which are positioned at the junctions of the crossbar.