Maestría en Ingeniería en Automatización de Procesos Industriales

Title

EI-SCAM: EDA tool for the symbolic and sensitivity analysis of analog/RF circuits and noise assessment of electronic interfaces

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El-SCAM: EDA Tool for the symbolic and sensitivity analysis of analog/RF circuits and noise assessment of electronic interfaces

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1. Introduction

Modern integrated circuits are enormously complicated, often containing hundreds of even millions of devices. The realization of such circuits would not be possible without the use of software supporting all stages of the design process. The tools used for this task are known as electronic design automation (EDA) tools.

This paper presents a new EDA tool for the symbolic and sensitivity analysis of analog/RF circuits as well as the noise assessment of electronics interfaces.

2. Objectives

2.1. General objective

Develop a EDA tool for the symbolic and sensitivity analysis of analog/RF circuits and noise assessment of electronic interfaces in MATLAB.

2.2. Specific objectives

- To Enhance SCAM tool by including new elements for analysis such as: controlled sources (voltage controlled voltage source, voltage controlled current source, current controlled voltage source, current controlled current source), gyrator, baluns, BJT, MOSFET and noise models of active devices.
- To Improve SCAM by changing the solution method by another one whose computing speed is faster and thus allows the solution of larger circuits.

3. Methodology

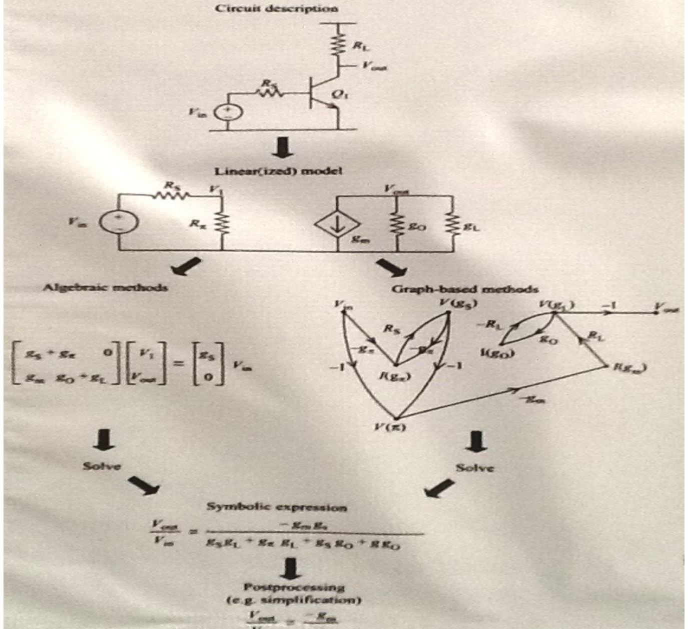

Figure1. Methodology used by symbolic analysis

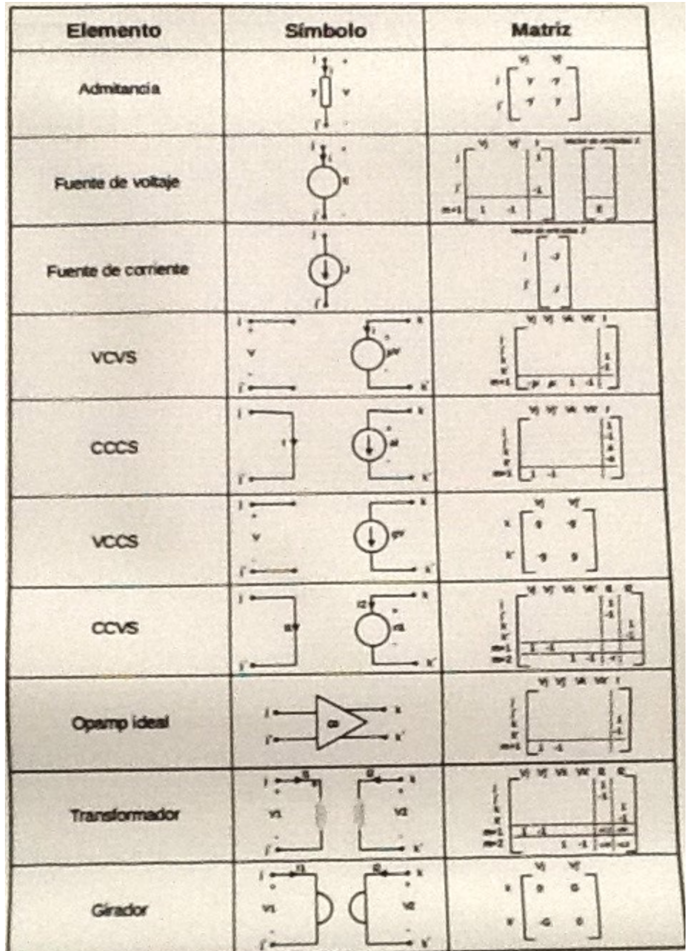

Table 1. Electronic elements used in electronic circuit analysis.

Element	Noise Models	
Resistor R	R (Noiseless) $\overline{V_n^2}(f) = 4kTR$	R (Noiseless) $\overline{I_n^2}(f) = \frac{4kT}{R}$
BJT (Active region)	$V_i^2(f)$, $I_i^2(f)$ (Noiseless); $V_i^2(f) = 4kT\left(r_b + \frac{1}{2g_m}\right)$; $I_i^2(f) = 2q\left(I_B + \frac{KI_B}{f} + \frac{I_C}{\lvert\beta(f)\rvert^2}\right)$	
MOSFET (Active region)	$V_g^2(f)$, $I_d^2(f)$; $V_g^2(f) = \frac{K}{WLC_{ox}f}$; $I_d^2(f) = 4kT\left(\frac{2}{3}\right)g_m$	$V_i^2(f)$ (Noiseless); $V_i^2(f) = 4kT\left(\frac{2}{3}\right)\frac{1}{g_m} + \frac{K}{WLC_{ox}f}$; Simplified model for low and moderate frequencies
Opamp	$I_{n-}^2(f)$, $V_n^2(f)$, $I_{n+}^2(f)$ (Noiseless)	$V_n(f)$, $I_{n-}(f)$, $I_{n+}(f)$ — Values depend on opamp — Typically, all uncorrelated

Table 2. Noise models

$$\det(M) = \begin{vmatrix} a & b & 0 & 0 \\ c & d & e & 0 \\ 0 & f & g & h \\ 0 & 0 & i & j \end{vmatrix} = adgj - adhi - aefj - bcgj + cbhi$$

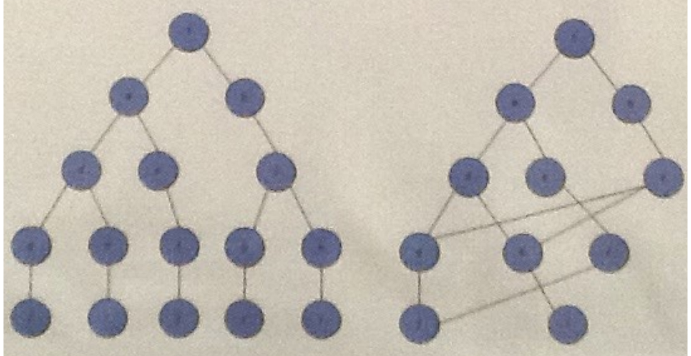

Figure 2. Determinant Decision Diagram

4. Results

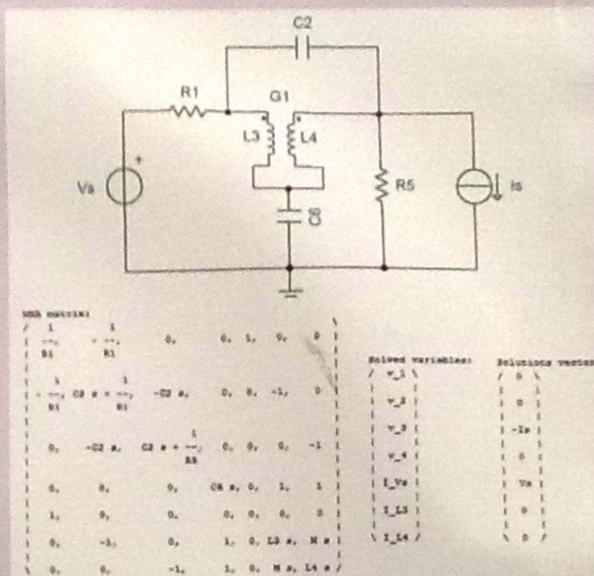

Figure 3. Example MNA Matrix with Gyrator.

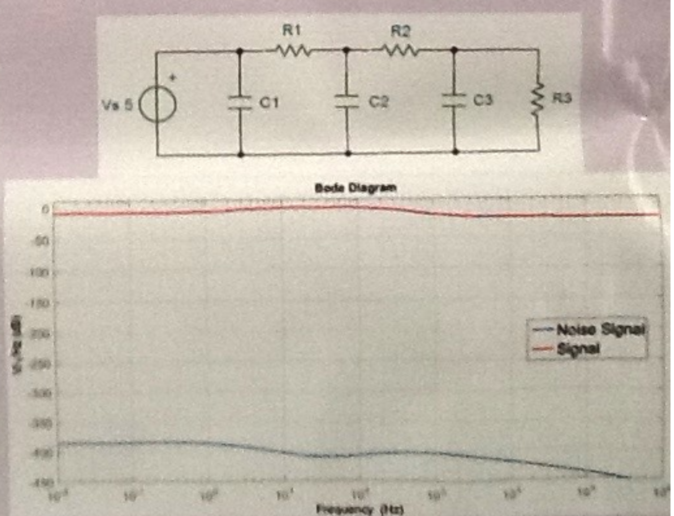

Figure 4. Example MNA matrix evaluating noise in circuit

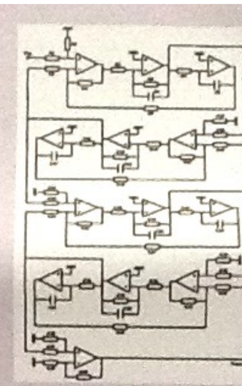

Figure 5. Active bandpass filter as proposed benchmark circuit for the comparision of Symbolic simulators.

Filter	Matrix size	Mathematica	SCAM	I-SCAM
Sallen-Key	7	0.017 sec	1.09 sec	2.74 sec
Multifilter	15	0.297 sec	3.6 sec	2.99 sec
Bandpass	46	35097 sec	No	12081 sec

Table 3. Comparation of solution methods.

5. Conclusion

According to the results it can be concluded that the program works correctly and is available to use for students, teachers and researchers. The next goal is to improve the solution time circuits using a technique called Determinant Decision Diagram (DDD´s).

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