Project 1

ECE 5/413 – RF IC Design

1 Problem Statement

LNA Design: Your company wants to enter the new 28GHz mmWave wireless market and you are tasked to design a single-ended low-noise amplifier for the product. You may choose any suitable circuit topology or number of stages. The LNA should meet the following specifications in the 90nm CMOS technology:

Table 1: LNA design specifications.

Parameter	**Value**
Technology	90nm CMOS
Supply voltage, V_{DD}	1.2V
Input impedance, R_{in}	50Ω
Frequency range	26.5-29.5 GHz
S_{11}	$< -15dB$
S_{12}	$< -35dB$
Power gain	$\geq 8\,dB$ over the whole band
On-chip load (a mixer)	$100fF$
NF	$< 4dB$
IIP_3	$\geq -5dBm$
$FoM = \frac{G_p \cdot IIP_3 \cdot f}{(F-1)\cdot P}$	Maximize

- Ideal inductors are not allowed in the final design. Use the scalable inductor model provided on the server. The models are usually extracted using an electromagnetic simulator.

2 Report

Submit your neatly typed report as a **PDF** file (*Lastname_ECEx13_Project1_Report.pdf*). The report will include:

- Neatly drawn schematics with transistor sizes, bias currents, inductors and their equivalent circuit.
- Preliminary hand-calculations based on simulated transistor parameters.
- You may copy the testbenches from the instructor. Simulation results of the main specification parameters at $25°C$ with 1.2 V supply. At the minimum, plot the following:
  - S_{21} and G_{max} in dB scale.
  - S_{22} and S_{11} on the same plot and scale in dB
  - Input impedance (real and imaginary parts of parameter $ZM_1$from sp analysis)

  - NF and NF_{min} in dB
  - Plot P_{1dB} and IIP_3 separately using a harmonic balance simulation setups.
- Show the overall LNA design performance with the FoM in a neatly tabulated manner along with the conclusion.
- **For Grad Students only:** Simulate NF, S_{11}, S_{22} and S_{21} at $125°C$ with 1.0 V supply. Comment on the results.

You can download the Visio schematic symbols from the course website [3]. Provide relevant references in your report.

3 Academic Honesty

You are expected to come up with your original design schematics. No circuits can be shared or copied from other student(s).

4 Grading Scheme

Design choices and justification 30%

Functionality and performance 30%

Design characterization and presentation of results 30%

Report presentation and clarity 10%

References

[1] T. Johansson, "LNA Simulation using Cadence SpectreRF," RF IC Design 2018, Linkoping University [Online].

[2] Cadence SpectreRF Workshop: LNA Design Using SpectreRF [Online].

[3] Visio Schematic Symbols. Available [Online].