EE6347 - Devices for AI and Neuromorphic Computing

Tutorial 2

Task 1: Verilog - A Model in ADS

1. Write the Verilog Model introduced previously in the course as a Verilog-A View in ADS. You may use the following hyperparameters to begin with:

```
1   `include "constants.vams"
2   `include "disciplines.vams"
3
4   module RRAM(TE,BE,T,G);
5
6       inout TE,BE;
7       electrical TE,BE,T,G,Gap, n1, Temp;
8
9       parameter real k      = 1.38e-23;
10      parameter real q      = 1.602e-19;
11      parameter real g0     = 0.8e-9;
12      parameter real V0     = 0.2;
13      parameter real I0     = 0.65e-4;
14      parameter real ve0    = 10e6;
15      parameter real Eam    = 1.29;
16      parameter real a      = 0.8e-10;
17      parameter real gamma0 = 30;
18      parameter real b      = 10.0;
19      parameter real c      = 1.0;
20      parameter real L      = 10e-9;
21      parameter real gmax   = 3.3e-9;
22      parameter real gmin   = 0.2e-9;
23      parameter real gini   = 3.3e-9;
24      parameter real r_cf   = 4e-9;
25      parameter real rho    = 1e-3;
26      parameter real Rth    = 3e6;
27      parameter real Tamb   = 300.0;
28      parameter real CC     = 5e-4;
29
30      real temp,gap,gamma,Ig,R,area;
```

2. Create a 4 port symbol for it. Create a testbench that applies a voltage across the electrodes. Read the currents from the T and G ports.

3. Perform a Quasi-DC sweep and plot the current through the electrodes vs the applied voltage

Task 2: Add a Thermal Capacitance to the Model

1. Plot the temperature and gap in time domain with the original model.

2. Find and add the right term to the model for thermal capacitance.
   You can use a Cth in the range of 0.04 - 1.1 pJ/K

3. Now plot the temperature and gap again and compare

Task 3: Set the Device to start at SET

1. Plot the Gap in time-domain with the original model

2. The device currently starts at a RESET. Change the code such that now it starts at a SET

3. Plot the Gap in time-domain with the modified model