CSE245 Spring 2023 Homework 1

Due Time : 11:50pm, Wednesday April 26, 2023 Submit to Gradescope
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1. Use NGSpice to simulate a simple but nontrivial dynamic circuit. Plot the circuit, print the system equation, and explain the relationship between the circuit and the equation i.e. state variables, system matrices, input/output vectors.

2. Given a circuit of $n_1 \times n_2 \times n_3$ mesh. Each edge is a resistor with 1 Ω resistance.

i. Write the system equations following the formats of lecture notes 1 and 2, i.e. Sparse Tableau Analysis, Nodal Analysis, Tree Analysis, and Link Analysis.

ii. Write the 4 smallest eigenvalues and corresponding eigenvectors of these matrices.

iii. Write the 4 largest eigenvalues and corresponding eigenvectors of these matrices.

iv. Check the relationship of eigenvalue eigenvector pairs among these different matrices in ii and iii.

2.1. Derive the solution for the circuit with the following different sizes of meshes.
2.1.1 The mesh size is $1 \times 1 \times 4$.
2.1.2 The mesh is $1 \times 4 \times 4$.
2.1.3 The mesh is $4 \times 4 \times 4$.
2.2. Compare the eigenvalues and eigenvectors (from ii and iii) among the above three meshes (2.1.1-3).

3. Given a nonlinear capacitor, we have charge $q = f(v)$. The capacitor is in series with a constant current source $i_s = 1amp$. The initial charge $q = 0$ at time $t = 0$ Derive the integration equation for the voltage of the capacitor. Simulate and draw the curve of the voltage for time interval $[0, 10]$ second.
3.1. $f(v) = v$.
3.2. $f(v) = v^2$.
3.3. $f(v) = v^{1/2}$.