Computer-Aided Design and Analysis. Final 2022 Spring

June 16, 2022, 14:20 - June 17, 2022,14:19

Please answer the following 5 questions and email to me (f06548032@g.ntu.edu.tw). This is a closed book exam. No books, notes, or previous source code be used during the exam. You can use MATLAB and LTSPICE.

Read all questions first. You may not request clarification after 4:20 pm. Write your questions on below URL

https://docs.google.com/spreadsheets/d/1b-IxwxHS4OeWf1PKZ76PqKCX-v5p22cY-AIOaK-IL34/edit?usp=sharing

Compress all source code, figure and writing (on ipad or on sheet) to ZIP, then email to me before June 17, 2022,14:19. You should provide your name and student ID in the Email. The exam score will send to your email on 6/23 (Wed) at the latest. You can check exam scores on 6/23 (Thu) 14-16 pm in the classroom (BL212).

1. MNA with Reactive Elements: Applying MNA to circuits with inductors ($v(t) = L \cdot \frac{di(t)}{dt}$) and capacitors ($i(t) = C \cdot \frac{dv(t)}{dt}$) presents no special difficulty if we use the complex impedance of these elements.

$$Z_R = R, Z_L = sL = j\omega L, Z_C = \frac{1}{sC} = -\frac{j}{\omega C}$$

That is, for equation $(G + sC)V = I$, we also need to modify the matrices. You can find a modified example in here: goo.gl/vBtgbT [1].

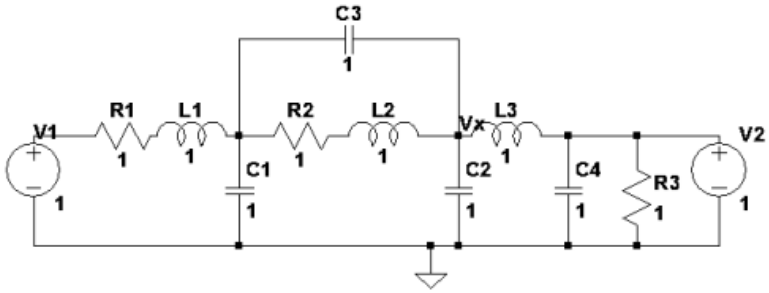
(a) (15%) Derive the MNA equations (matrix G, C, V and I) for the circuit below. Perform transient simulation at **Vx** by using **eigenvector method**. Let time step be 0.1s and simulate for 20s. Plot the results in one figure.

Replace all inductors (L1, L2 and L3) with resisters (R4, R5 and R6) and the values of them are **2**. Perform transient simulation at **Vx** by using **different methods below**. Let time step be 0.1s and simulate for 20s. Plot the results in one figure.

(b) (10%) Use **forward Euler method**.

(c) (10%) Use **trapezoidal method**.

(d) (10%) Use **SPICE**.



Files to commit P1.m, P1_forward.fig, P1_trapezoidal.fig, P1.asc, P1.PNG

(45%)

2.

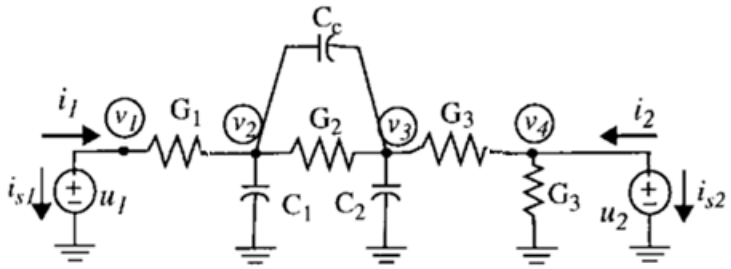
(a) Derive the MNA equations for the above circuit.

Perform transient simulation at V3 by using different methods below. Let time step 0.1 second and simulate for 20 seconds. Plot the results in one figure.

(b) Use **eigenvector method**

(c) Use **trapezoidal method**.

(d) Use **SPICE**.



Note: All parameters are 1

Files to commit P2.m, P2_forward.fig, P2_trapezoidal.fig, P2.asc, P2.PNG

(30%)

3. (20%)

LU decomposition

Please prove that LU decomposition and Gaussian elimination are equivalent.

4. (20%)

Cholesky decomposition (LDLT decomposition)

(a) Derive the Cholesky decomposition formula without square root. ($A = LDL^T$)

(b) Implement the algorithm derived in (a) using Matlab .m file. The function should be $[L, D] = LDLT(A)$, where A, L and D are n by n matrices and n is not fixed.

***Files to commit: LDLT.m**

5. (20%)

Nodal Analysis (NA):

Derive NA (Nodal Analysis) for **Fig.1** circuit, all the voltage and resistance value is 1.

(a) Find out the nodal voltage of Vx using NA(Nodal Analysis) and implement it.

(b) Using LTspice to generate the circuit and export the voltage data. Print the exported voltage at arbitrary time to show that the results are the same.

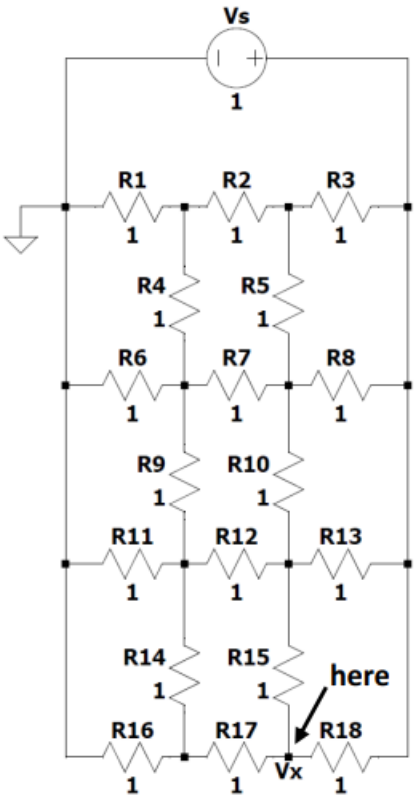


Fig.1