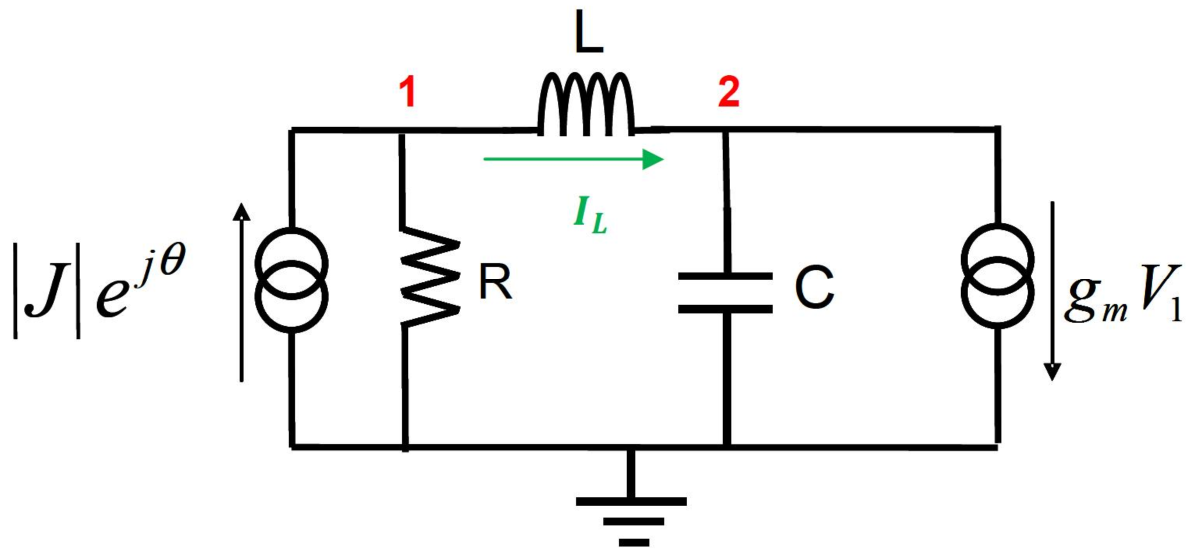
Question #1:

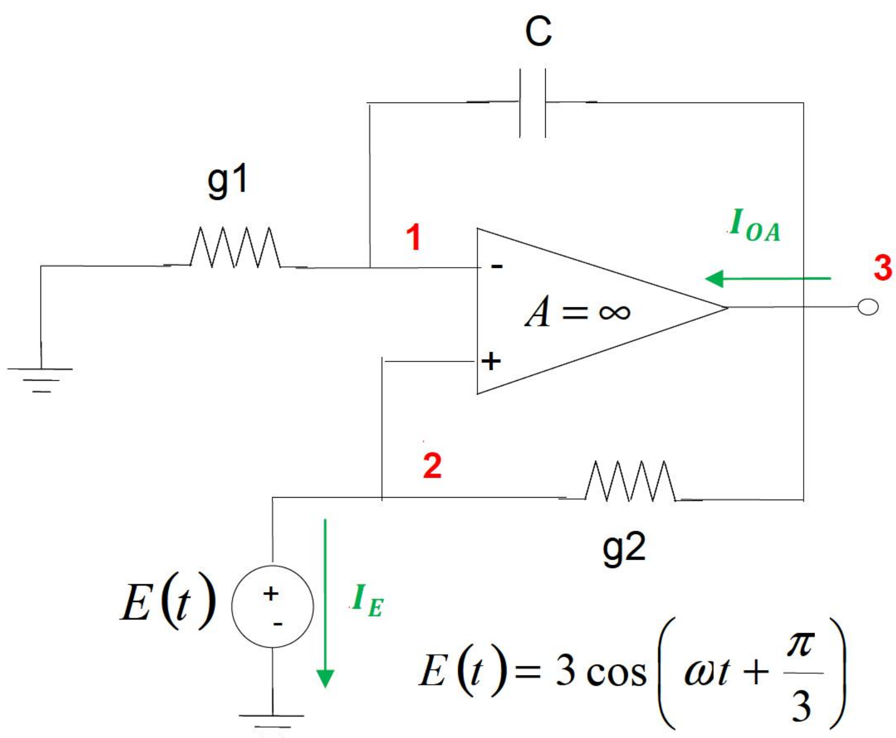
Write the frequency and time-domain MNA equations for the following circuit.



Electrical Circuits, Project #2
Dr. Sadr, University of Tehran

Question #2:

Write the frequency MNA equations for the following circuit.



If the gain of the operational amplifier as a function of frequency is given by: $A = \frac{k_1}{s+k_2}$ where k_1 and k_2 are constants, write the time-domain MNA equations for the circuit

Question #3

Write a computer program to formulate the frequency domain MNA SPARSE equations in the form (G+sC) X = b

Specifications:

INPUT: Netlist in a SPICE-like format or equivalent

Components: resistors, capacitors, inductors, voltage sources, current sources, current-controlled voltage sources, voltage-controlled current sources

OUTPUT: Frequency response (magnitude and phase)

Verify manually the correctness of your formulation using simple circuits. Include these circuits in your report.

Question #4

Use the program in (3) and the sparse commands in MATLAB to write a program to compute the frequency response of the circuits shown in Figure 1-2 using LU decomposition and forward/backward substitution.

Plot the response vs frequency. Verify your results using HSPICE (or equivalent).

Plot the sparsity pattern of the MNA matrix before and after the LU decomposition.

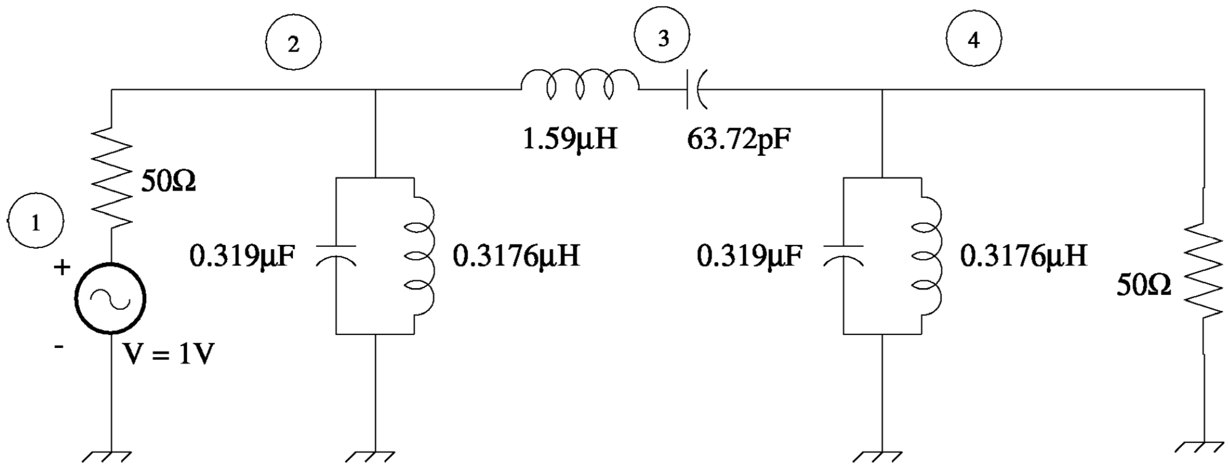


Figure 1.

R_{1a}= 9,606Ω	C_3=C_4=15nF	$V_i = 1V$
R_{1b}= 23,280Ω	R_3=R_4=9,304Ω	
R_2=6.8KΩ	R_q=52,107Ω	Gain of all OpAmps = 50,000
C_1=94.9nF	R_g=9,304Ω	
C_2=20.5nF	r=20KΩ	

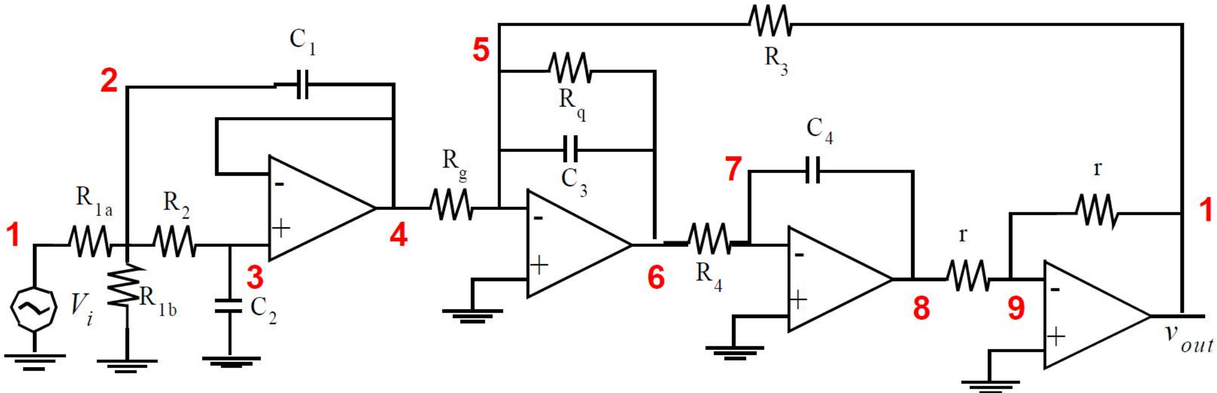


Figure 2.

Question #5

Consider the linear algebraic equation Ax=b; where A and b are generated using the listed code. Compare the two following scenarios for solving for x in terms of memory and CPU time.

Scenario#1: treat A as a sparse matrix

a) **Plot the sparsity pattern of A**

b) **Plot the sparsity pattern of the LU factors of A**

c) **Find x and verify its accuracy**

d) **Find the CPU time required for the LU decomposition and the F/B substitution.**

e) **Plot the CPU time vs. n for 1000<n<30,000**

Program:

```
clear
global A n b
n=4000;     %number of nodes
A=sparse(n,n);
b=sparse(n,1);
b(1)=1;
for i=1:n
   if i<=n-5
       A([i,n-4-i],[i,n-4-i])=A([i,n-4-i],[i,n-4-i])+[1,-1;-1,1];
   end
   if i>=6
       A([i,n+5-i],[i,n+5-i])=A([i,n+5-i],[i,n+5-i])+[1,-1;-1,1];
   end
   if i<=n-5
       A([i,i+5],[i,i+5])=A([i,i+5],[i,i+5])+[1,-1;-1,1];
   end
   if i<=n/2
       A([i,n+1-i],[i,n+1-i])=A([i,n+1-i],[i,n+1-i])+[1,-1;-1,1];
   end
end
tic
[L,U,P,Q] =lu(A,0.1);
z=L\(P*b);
Y=U\z;
X=Q*Y;
t = toc;
spy(A)
title('Sparisty of A');
spy(L)
title('Sparisty of L');
spy(U)
title('Sparisty of U');
```