**Carleton University**
**Department of Electronics**

# Practice Questions (set 1)

***Note:***

- *Questions marked with the symbol* ✍ *requires a* written answer *(hand-written / typed, simulation is not needed)!*

***For the following questions:***

*(a) Written answer is required.* ✍

*(b) Include the circuit in your answer and clearly show how you numbered the nodes on your circuit diagrams.* ✍

*(c) Clearly show the size and all the entires of the matrices (i.e.* $\mathbf{G}$*,* $\mathbf{C}$*,* $\mathbf{A}$*),* $\mathbf{X}$*, and* $\mathbf{b}$ *in your answers.* ✍

- *The entries that are complex numbers should be shown in "*$a + jb$*" format.*
- *The entries of* $\mathbf{X}$ *and* $\mathbf{b}$ *(signals) in freq. domain should be shown as explicit functions of* $s$*, where* $s = j\omega$*, (e.g. show* $I_1(s)$ *and NOT simply* ~~$I_1$~~*).*
- *Similarly, in time domain they should be shown as explicit functions of time* $t$ *(e.g. show* $i_1(t)$ *and NOT simply* ~~$i_1$~~*).*

## MNA Matrix Equations

**Question 1:** Write the MNA frequency-domain matrix equations in the form $\mathbf{AX} = \mathbf{b}$, for the following circuits. ✍

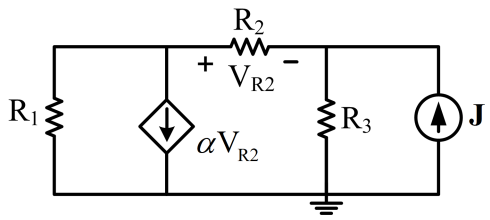


Figure 1: Circuit 1.1

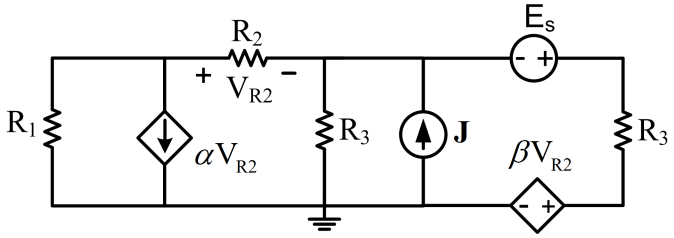


Figure 2: Circuit 1.2

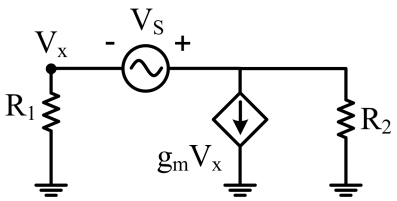


Figure 3: Circuit 1.3

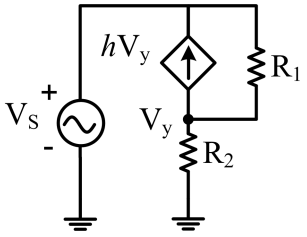


Figure 4: Circuit 1.4

**Question 2:** For the following circuits,

(a) Write the MNA frequency-domain matrix equations in the form $\overbrace{(\mathbf{G}+s\mathbf{C})}^{\mathbf{A}}\mathbf{X}=\mathbf{b}$.

(b) Write the MNA time-domain matrix equations.

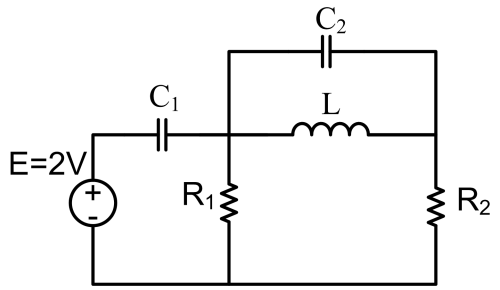


Figure 5: Circuit 2.1

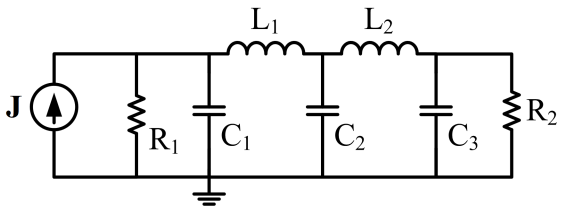


Figure 6: Network 2.2

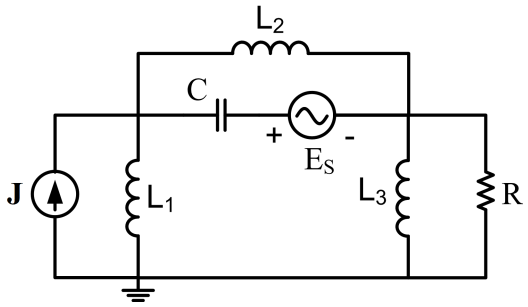


Figure 7: Circuit 2.3

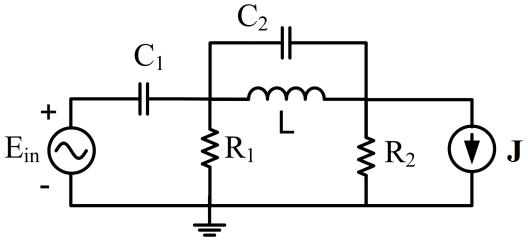


Figure 8: Network 2.4

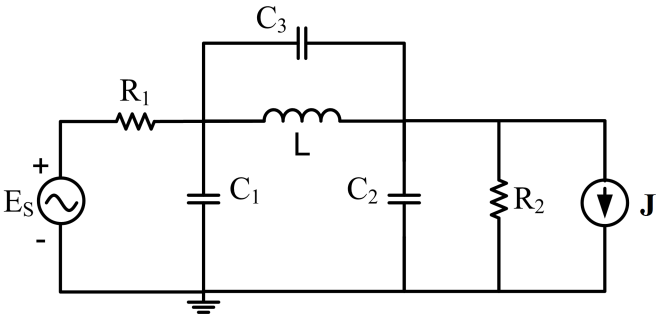


Figure 9: Circuit 2.5

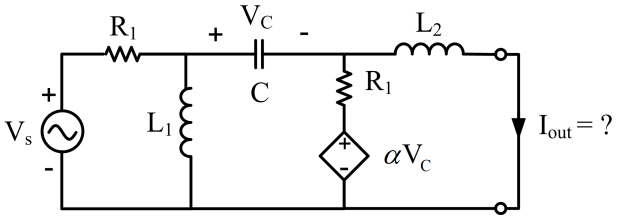


Figure 10: Network 2.6

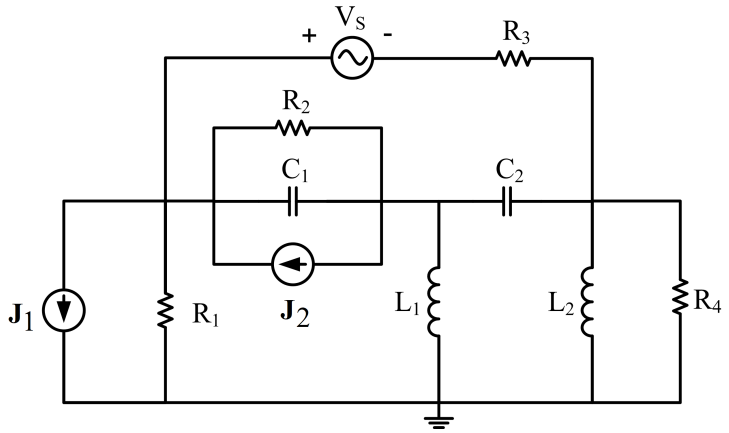


Figure 11: Circuit 2.7

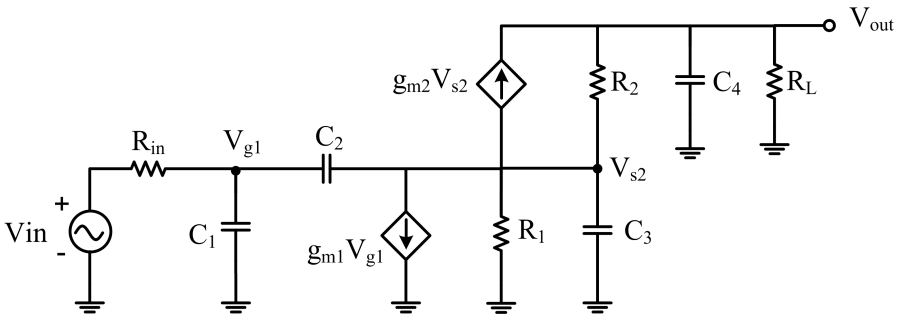


Figure 12: Circuit 2.8

**Question 3:** For the following circuits,

(a) Write the MNA frequency-domain matrix equations in the form $\overbrace{(\mathbf{G}+s\mathbf{C})}^{\mathbf{A}}\mathbf{X}=\mathbf{b}$.

(b) Write the MNA time-domain matrix equations.

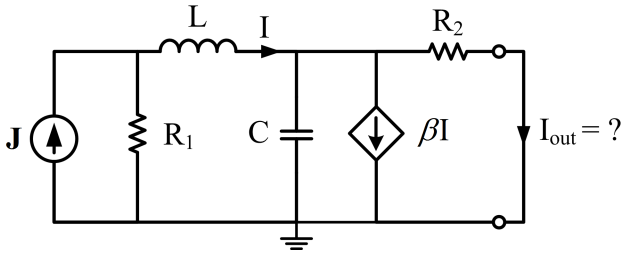


Figure 13: Circuit 3.1

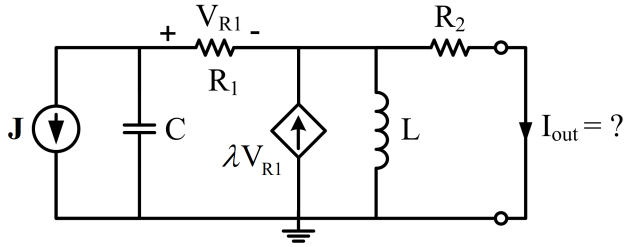


Figure 14: Network 3.2

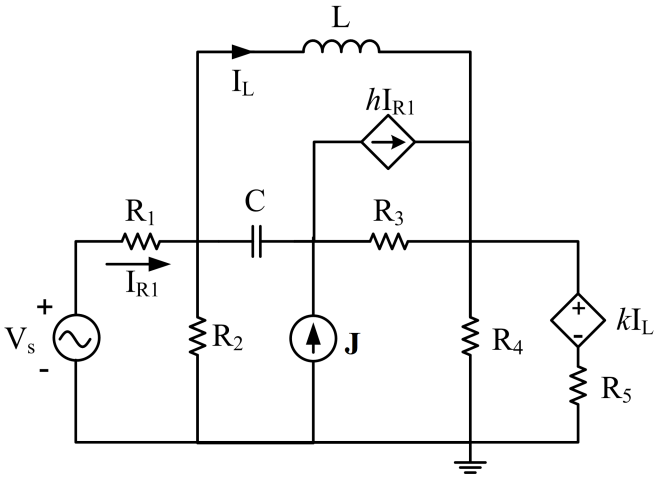


Figure 15: Circuit 3.3

**Question 4:** For the following Op-amp circuits,

(a) Write the MNA frequency-domain matrix equations in the form $\overbrace{(\mathbf{G}+s\mathbf{C})}^{\mathbf{A}}\mathbf{X}=\mathbf{b}$.

(b) Write the MNA time-domain matrix equations.

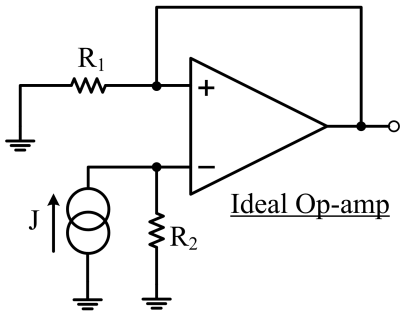


Figure 16: Circuit 4.1

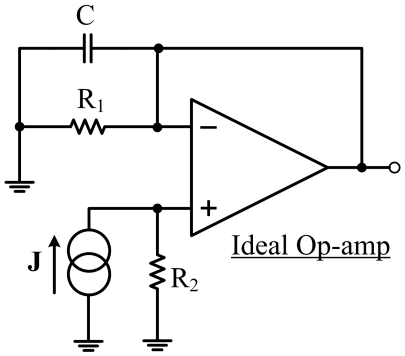


Figure 17: Circuit 4.2

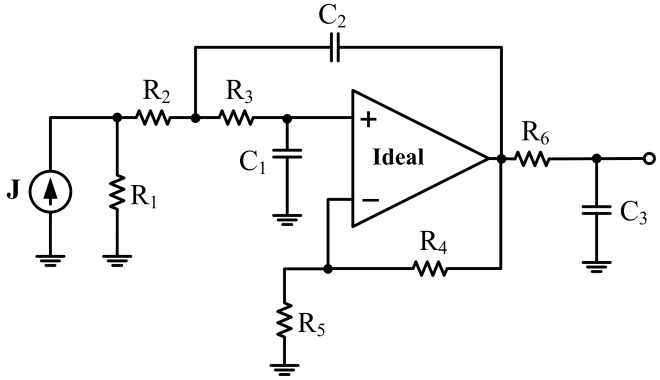


Figure 18: Network 4.3

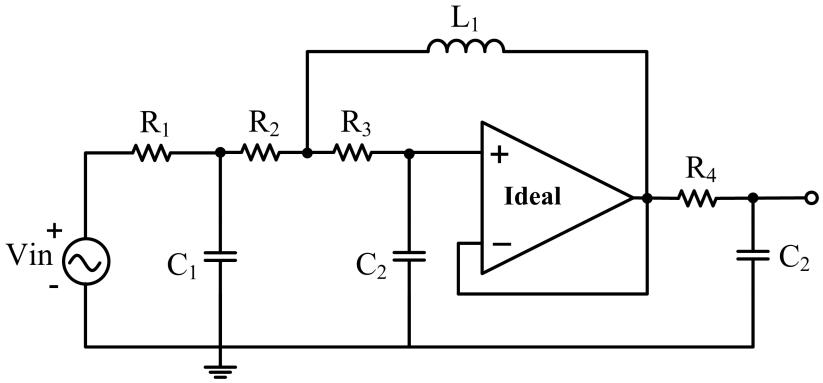


Figure 19: Network 4.4

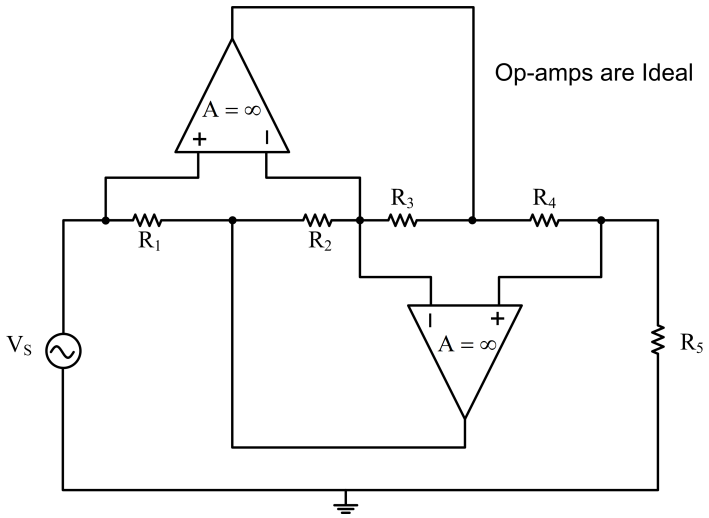


Figure 20: Network 4.5

**Question 5:** For the following circuits,

(a) Write the MNA frequency-domain matrix equations in the form $\overbrace{(\mathbf{G}+s\mathbf{C})}^{\mathbf{A}}\mathbf{X}=\mathbf{b}$.

(b) Write the MNA time-domain matrix equations.

**Note:** The entries that are complex numbers should be shown in "$a+jb$" format.

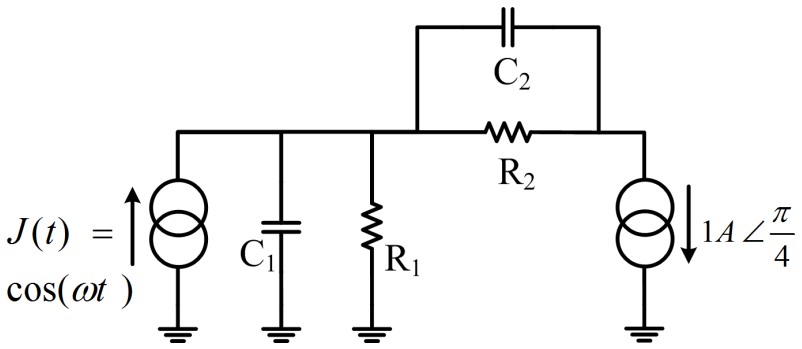


Figure 21: Circuit 5.1

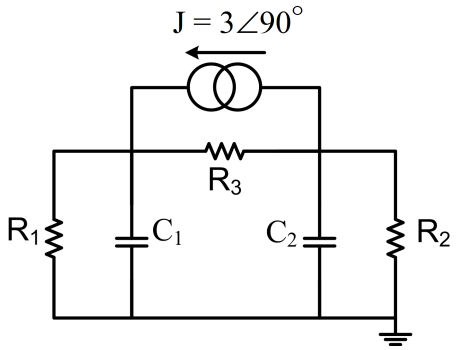


Figure 22: Circuit 5.2

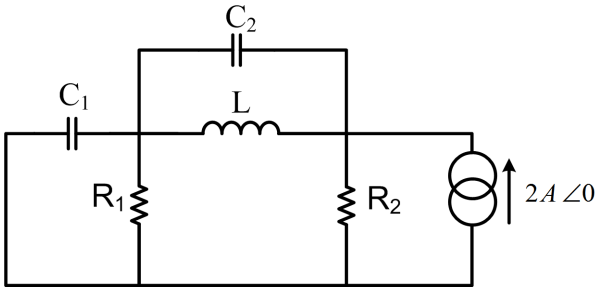


Figure 23: Circuit 5.3

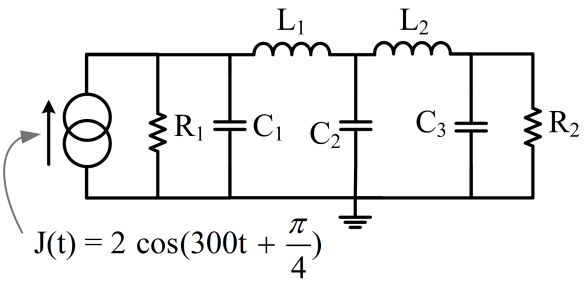


Figure 24: Circuit 5.4

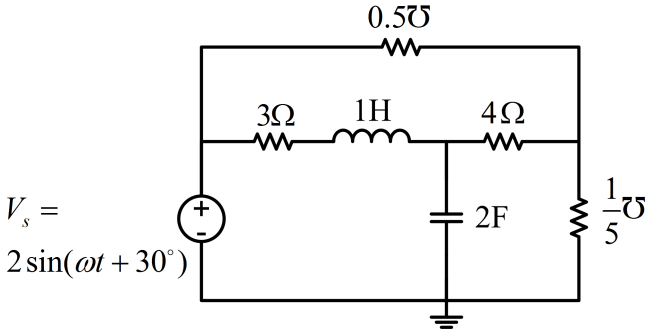


Figure 25: Circuit 5.5

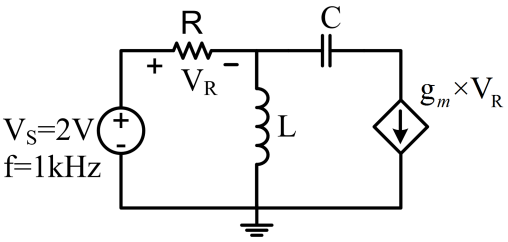


Figure 26: Circuit 5.6

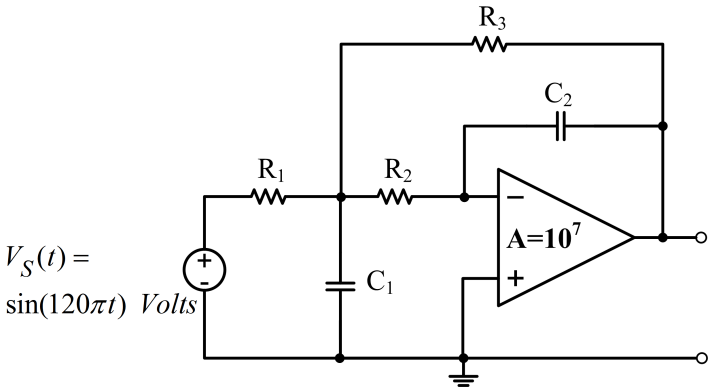


Figure 27: Circuit 5.7

**Question 6:** The frequency-domain simulation results for the circuits at $f = 1\,kHz$ is given as shown in the following figures.

(a) What is the **steady-state** output in time-domain $v_{out}(t)$

(b) What is the frequency-domain transfer function at the given frequency?

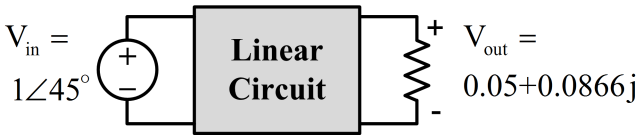


Figure 28: Network 6.1

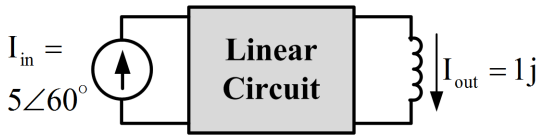


Figure 29: Network 6.2