Problem 2: First-Order Networks – 30%

This problem concerns the network shown below. When excited from rest at $t = 0$ with a 1-V step the network should produce the output voltage $v_{\text{OUT}}$ shown below when the output port is unloaded. The expression for the output voltage is

$$v_{\text{OUT}} = 1\, \text{V} \left( \frac{1}{3} + \frac{2}{3} \left( 1 - e^{-\left(\frac{t}{\tau}\right)} \right) \right) u(t)$$

where the time constant $\tau$ is 1 ms.
Shown below are eight possibilities for the network. They are labeled A through H. *Note that the labels A through F are in the upper right corner of the corresponding network while the labels G and H are in the center.* The networks are referenced in Parts A and B.
Consider the eight networks labeled A through H. From these, identify one network that can be used to implement the desired step response given excitation from rest and appropriate values for its resistances and capacitances. Circle the label for that network on the line below, and then clearly explain why the network can provide the desired step response.

A  B  C  D  E  F  G  H

Circle:

Explain:
(2B) Analyze the network identified in Part A and determine the values of its two unknown elements. Note that each network has one resistance set to 1 kΩ. Numerical results with appropriate units are expected for the unknown element values.
Shown below are eight more possibilities for the network. They are labeled I through P. Note that the labels I through N are in the upper right corner of the corresponding network while the labels O and P are in the center. The networks are referenced in Parts C and D.
(2C) Consider the eight networks labeled I through P. From these, identify one network that can be used to implement the desired step response given excitation from rest and appropriate values for its resistances and inductances. Circle the label for that network on the line below, and then clearly explain why the network can provide the desired step response.

Circle:

A B C D E F G H

Explain:
(2D) Analyze the network identified in Part C and determine the values of its two unknown elements. Note that each network has one resistance set to 1 kΩ. *Numerical results with appropriate units are expected for the unknown element values.*