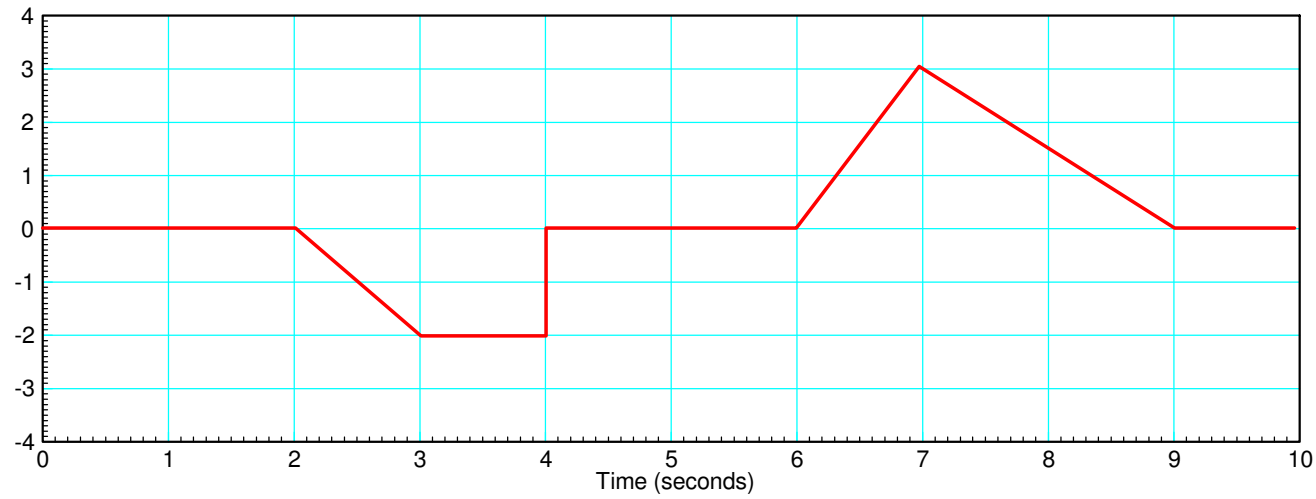
ECE 111: Handout #11

Week #8: ECE 351 Electromagnetics

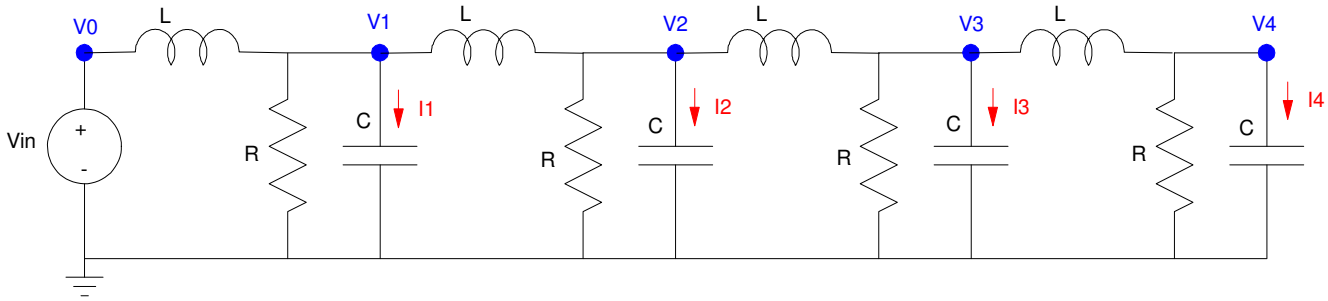
1) Assume the current flowing into a 1H inductor is as shown below. Sketch the voltage.

- $V = L\frac{dI}{dt}$



2) Write the differential equations which describe the following circuit. Assume

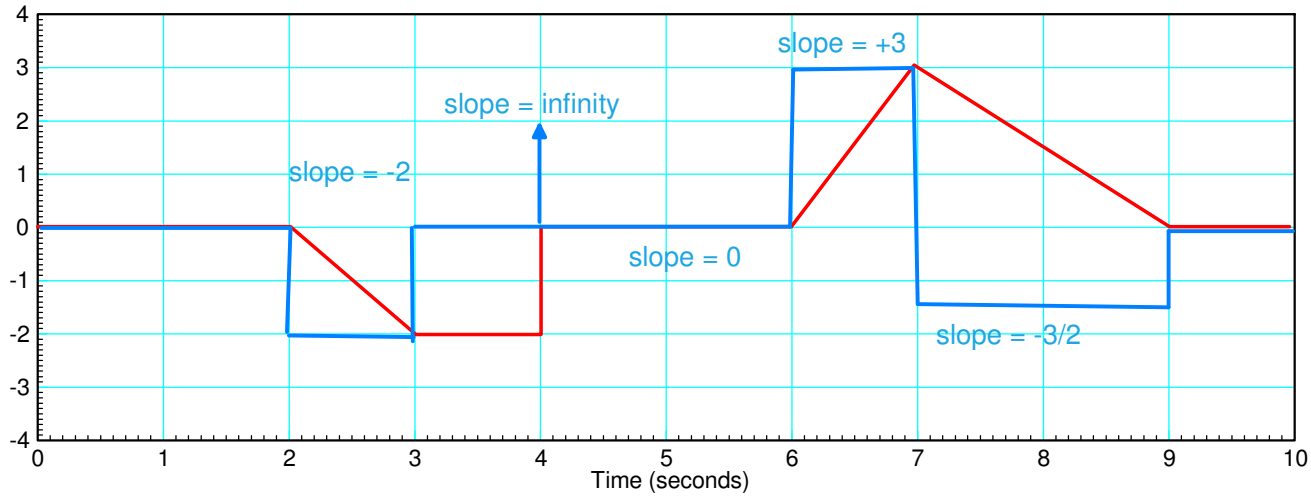
- L = 0.1 H
- C = 0.1 F
- R = 10 Ohms



Solutions

1) Inductors are differentiators:

$$V = L\frac{dI}{dt}$$



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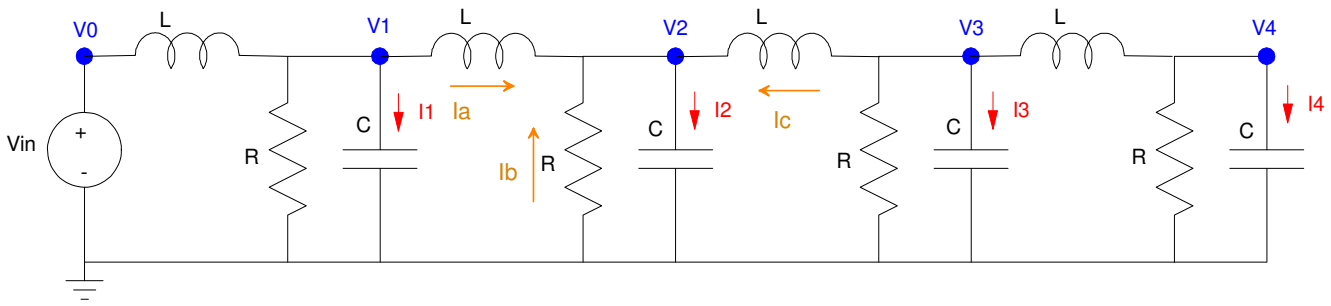

Use the VI relationship for R, L, and C

$$V = IR, \qquad V = L\frac{dI}{dt}, \qquad I = C\frac{dV}{dt}$$

$$V_1 - V_2 = L\dot{I}_a$$

$$V_3 - V_2 = L\dot{I}_c$$

$$I_b = -\frac{V_2}{R}$$

The node eqution at V2 is

$$I_2 = C\dot{V}_2 = I_a + I_b + I_c$$

$$C\dot{V}_2 = I_a - \left(\frac{V_2}{R}\right) + I_c$$

Differentiate

$$C\ddot{V}_2 = \dot{I}_a - \left(\frac{\dot{V}_2}{R}\right) + \dot{I}_c$$

$$C\ddot{V}_2 = \left(\frac{V_1 - V_2}{L}\right) - \left(\frac{\dot{V}_2}{R}\right) + \left(\frac{V_3 - V_2}{L}\right)$$

Ditto for nodes 1..3. Node 4 is a little different since no node #5

$$C\ddot{V}_1 = \left(\frac{V_0 - V_1}{L}\right) - \left(\frac{\dot{V}_1}{R}\right) + \left(\frac{V_2 - V_1}{L}\right)$$

$$C\ddot{V}_2 = \left(\frac{V_1 - V_2}{L}\right) - \left(\frac{\dot{V}_2}{R}\right) + \left(\frac{V_3 - V_2}{L}\right)$$

$$C\ddot{V}_3 = \left(\frac{V_2 - V_3}{L}\right) - \left(\frac{\dot{V}_3}{R}\right) + \left(\frac{V_4 - V_3}{L}\right)$$

$$C\ddot{V}_4 = \left(\frac{V_3 - V_4}{L}\right) - \left(\frac{\dot{V}_4}{R}\right)$$