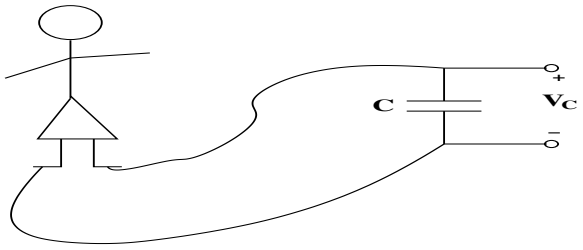
School of Engineering
Department of Electrical and Computer Engineering

332:221 **Principles of Electrical Engineering I** **Fall 2012**
Quizlette 7

USING A CALCULATOR WILL SLOW YOU DOWN! Final answers must appear in the appropriate box. Show your work outside the box.

1. **Basic Stuff:** Emma the Electrical Engineer is angry at her arch nemesis, Castor, and in a fit



of rage throws a 1kg rock at what she thinks is Castor's house. Emma is very strong and the rock's velocity when it hits is 50m/s. However, unbeknownst to Emma, Castor, is a great engineer and has designed his house as a mechano-electric transducer – movement of his house is converted directly into electrical energyand stored in a capacitor. Also unbeknownst to Emma, Castor knows of her plan and has attached leads to Emma's shoes which are in turn attached to the capacitor charged by Castor's house as shown in the figure.

(a) *(2 pts)* Write down the energy stored in the capacitor in terms of C and V_C.

$$E_c = \frac{1}{2}CV_C^2$$

(b) *(3 pts)* If all the kinetic energy in Emma's rock is converted into electrical energy, what is the voltage across Emma's feet after the rock hits if $C = 10^{-6}F$? Assume $V_C = 0$ before the rock hits.

$$\frac{1}{2}mv^2 = \frac{1}{2}CV^2$$
$$V = v\sqrt{m/C}$$
$$V = 50,000 \textbf{ volts.}$$

2. **A Little Cute:**

The figure depicts a circuit with a resistor R, an inductor L and a capacitor C.

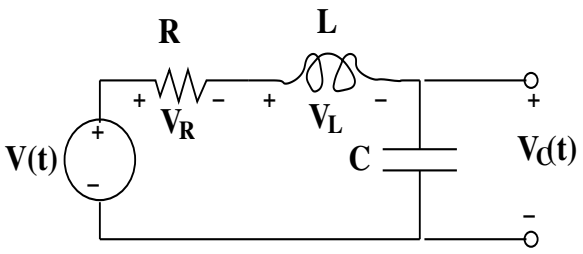


Figure 1:

(a) *(1 pt)* What is the constitutive relationship for the resistor?

$$V = IR$$

(b) *(1 pt)* What is the constitutive relationship for the inductor?

$$V_L = L\frac{dI_L}{dt}$$

(c) *(1 pt)* What is the constitutive relationship for the capacitor?

$$I_C = C\frac{dV_C}{dt}$$

(d) *(2 pt)* Using your circuit analysis skills, please provide a differential equation relating $V_C(t)$ to $V(t)$.

$$V_c + LC\frac{d^2V_C}{dt^2} + RC\frac{dV_C}{dt} = V(t)$$