Assignment1

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Problem 3.20a

Consider a causal LTI system implemented as the RLC circuit shown in fig. 1. In this circuit, $x(t)$ is the input voltage. The voltage $y(t)$ across the capacitor is considered the system output.

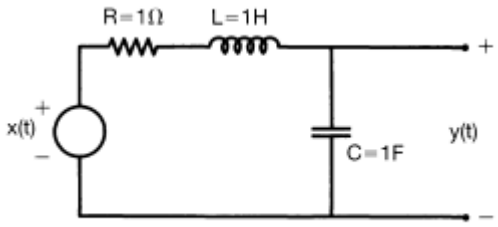

Figure 1: 3.20

Find the differential equation relating $x(t)$ and $y(t)$.
Solution:
For the capacitor,

$$q = CV_c$$

$$q = y(t)$$

Differentiating with time on both sides,

$$\frac{dq}{dt} = \frac{dy(t)}{dt}$$

Current flowing through the circuit is given by,

$$i = \frac{dy(t)}{dt}$$

Potential drop across the resistor is given by,

$$V_r = iR$$

$$V_r = \frac{dy(t)}{dt}$$

Potential drop across the inductor is given by,

$$V_l = L\frac{di}{dt}$$

$$V_l = \frac{d^2y(t)}{dt^2}$$

We have,

$$x(t) = V_r + V_l + V_c$$

$$x(t) = \frac{dy(t)}{dt} + \frac{d^2y(t)}{dt^2} + y(t)$$