Aug 5th - M

Example (problem 1.26)

An RLC circuit consists of three elements: a resistor (R), an inductor (L), and a capacitor (C). The flow of current across each element induces a voltage drop. Kirchhoff's second voltage law states that the algebraic sum of these voltage drops around a closed circuit is zero,

$$iR + L\frac{di}{dt} + \frac{q}{c} = 0$$

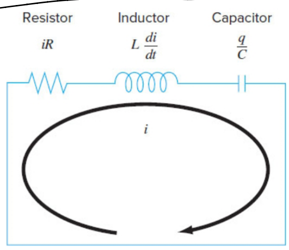
write in terms of $\frac{di}{dt}$

where i = current, R = resistance, L = inductance, t = time, q = charge, and C = capacitance. In addition, the current is related to charge as in

$$\frac{dq}{dt} = i$$

(a) If the initial values are $i(0) = 0$ and $q(0) = 1$ C, use Euler's method to solve this pair of differential equations from $t = 0$ to 0.1 s using a step size of $\Delta t = 0.01$ s. Employ the following parameters for your calculation: $R = 200$ Ω, $L = 5$ H, and $C = 10^{-4}$ F.

(b) Develop a plot of i and q versus t.



$$\frac{di}{dt} = \frac{-q}{CL} - \frac{iR}{L} \longrightarrow i_{new} = \left(\frac{-q}{CL} - \frac{i_{old} R}{L}\right)\Delta t + i_{old} \qquad ①$$

$$\frac{dq}{dt} = i \longrightarrow q_{new} = i_{new}\,\Delta t \qquad ②$$

Example
(problem 1.16)

Newton's law of cooling says that the temperature of a body changes at a rate proportional to the difference between its temperature and that of the surrounding medium (the ambient temperature),

$$\frac{dT}{dt} = -k(T - T_a)$$

where T = the temperature of the body (°C), t = time (min), k = the proportionality constant (per minute), and Ta = the ambient temperature (°C). Suppose that a cup of coffee originally has a temperature of 95°C.

a) Use Euler's method to compute the temperature from t = 0 to 20 min using a step size of 2 min if Ta = 20°C and k = 0. 19/min.

b) Plot the variation of temperature versus time from t = 0 to 20 min.

c) Include legend, x-label, y-label, and title in your plot.

$$T_{new} = [-k(T_{old} - T_a)]\Delta t + T_{old}$$