Computational physics

09-02-2017

In the figure, a RLC circuit is sketched. It is made of a voltage generator $V(t)$, a resistor R, an inductor L and a capacitor C.

The equation governing the evolution in time of the current $I(t)$ crossing the circuit is given by:

$$\frac{d^2I}{dt^2} + \frac{R}{L}\frac{dI}{dt} + \frac{1}{LC}I(t) = \frac{V'(t)}{L}$$

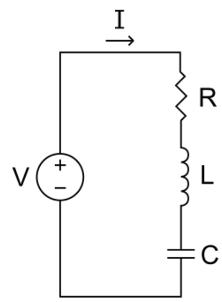
where: $V'(t)$ is the time derivative of the applied voltage.

The student should solve the above equation with a second order Runge-Kutta time scheme for a constant input voltage $V(t) = V_0$ and several combinations of parameters R, L and C in the following regimes:

$\frac{R}{2}\sqrt{\frac{C}{L}} < 1$ underdamped regime;

$\frac{R}{2}\sqrt{\frac{C}{L}} > 1$ overdamped regime;

$\frac{R}{2}\sqrt{\frac{C}{L}} = 1$ critically damped regime.



with initial conditions: $I(t = 0) = 0$ and $I'(t = 0) = 1$, by discussing how the solution changes in the three regimes.

Then, by fixing three values at choice for R, L and C and by using a sinusoidal input voltage $V(t) = V_0 \sin(\omega t)$ show that, for at least 7 different values of ω, the amplitude of the output current I has a maximum for a frequency: $\omega_0 = 1/\sqrt{LC}$.

In this case, use the initial conditions: $I(t = 0) = 0$, $I'(t = 0) = V_0\omega/R$.