2) $q(t) = q_0 e^{-\frac{Rt}{2L}} \cos\left(\sqrt{\frac{1}{LC} - \left(\frac{R}{2L}\right)^2}\, t\right)$

$\frac{R}{2L} = a, \sqrt{\frac{1}{LC} - \left(\frac{R}{2L}\right)^2} = b$

$q(t) = q_0 e^{-at} \cos(bt)$

$\dot{q}(t) = -[q_0 a e^{-at} \cos(bt) + q_0 b e^{-at} \sin(bt)] = -q_0 e^{-at}(a \cos(bt) + b \sin(bt))$

$\ddot{q}(t) = q_0 a e^{-at}(a \cos(bt) + b \sin(bt)) - q_0 e^{-at}(-ab \sin(bt) + b^2 \cos(bt))$

$= q_0 e^{-at}\{[a^2 \cos(bt) + ba \sin(bt)] - [ab \sin(bt) + b^2 \cos(bt)]\}$

$\ddot{q}(t) = q_0 e^{-at}\{(a^2 - b^2)\cos(bt) + 2ab \sin(bt)\}$

$L\ddot{q} + R\dot{q} + \frac{q}{C} = \emptyset$

ICs: $q(\emptyset) = q_0 = V_0 C$
$\dot{q}(\emptyset) = -\frac{R}{2L} q_0$

$q(\emptyset) = q_0 \cancelto{1}{e^{\emptyset}} \cancelto{1}{\cos(\emptyset)} = q_0$ ✓

$\dot{q}(\emptyset) = -q_0 \cancelto{1}{e^{\emptyset}}(a \cancelto{1}{\cos(\emptyset)} + b \cancelto{\emptyset}{\sin(\emptyset)}) = -q_0 a = -\frac{qR}{2L}$ ✓

$\ddot{q}(\emptyset) = q_0 \cancelto{1}{e^{\emptyset}}\{(a^2 - b^2)\cancelto{1}{\cos(\emptyset)} + 2ab \cancelto{\emptyset}{\sin(\emptyset)}\} = q_0(a^2 - b^2)$

$= q_0\left(\frac{R^2}{4L^2} - \frac{1}{LC} - \frac{R}{2L}\right)$