Ch 14. Prob. 80

$R = 7.0\,\Omega \quad L = 10\,mH \quad C = 3.0\,\mu F$

$Q_0 = 8.0\,\mu C \quad I_0 = 0$

a) find the charge on the capacitor after 5 cycles

Now $Q = Q_0 e^{-Rt/2L}\cos(\omega' t + \phi) \quad \omega' = \sqrt{\frac{1}{LC} - \left(\frac{R}{2L}\right)^2}$

$$\omega' = \sqrt{\frac{1}{(10\times10^{-3}H)(3.0\times10^{-6}F)} - \left(\frac{7.0\,\Omega}{2(10\times10^{-3}H)}\right)^2}$$

$$= \sqrt{3.33\times10^{7} - 1.23\times10^{5}} = 5{,}760\ rad/s$$

one oscillation is $T = \frac{2\pi}{\omega} = \frac{2\pi}{5760} = 1.09\times10^{-3}\,s$

5 oscillations is $t = 5T = \underline{5.45\times10^{-3}\,s}$

since we are going through complete oscillations $\cos(\omega t + \phi) = 1$

so $Q = Q_0 e^{-Rt/2L} = (8.0\times10^{-6}C)\,e^{-\frac{(7.0\,\Omega)(5.45\times10^{-3}s)}{2(10\times10^{-3}H)}}$

$= (8.0\times10^{-6}C)\,e^{-1.91} = (8.0\times10^{-6}C)(0.148)$

$= 1.19\times10^{-6}C = \boxed{1.19\,\mu C}$

This is 14.8% The original value.

b) 50 cyles

Now $t = 50T = 5.45\times10^{-2}\,s$

$Q = Q_0 e^{-Rt/2L} = (8.0\times10^{-6}C)\,e^{-\frac{(7.0\,\Omega)(5.45\times10^{-2}s)}{2(10\times10^{-3}H)}}$

$= (8.0\times10^{-6}C)\,e^{-19.1} = (8.0\times10^{-6}C)(5.07\times10^{-9})$

$= \boxed{4.06\times10^{-14}\,C}$

essentially all of the charge is dissipated.