For the fields to oscillate in an LC circuit, charge needs to move back and forth. This can only happen so fast due to resistance (if a non-superconducting circuit) and inertia \((F = ma)\).

\[\text{35-1}\]

(a) 4.0 A, of course!

(b) \(I_d = \varepsilon_0 \frac{d\Phi}{dt}\); therefore, \(\frac{d\Phi}{dt} = \frac{I_d}{\varepsilon_0} = \frac{4.0 \text{ A}}{8.85 \times 10^{-12} \text{ F/m}} = 4.5 \times 10^{11} \text{ Vm/s}\)
The displacement current between capacitors must equal that of current $I$ coming in, i.e., $I = I_d$. Flux through dielectric is given by
\[ \Phi = \frac{Q}{\kappa \varepsilon_0} \] (since $E = \frac{1}{\kappa} E_{\text{free}}$);
therefore, \[ \frac{d\Phi}{dt} = \frac{1}{\kappa \varepsilon_0} \frac{dQ}{dt} = \frac{1}{\kappa \varepsilon_0} I; \]
therefore, \[ I_d = I = \kappa \varepsilon_0 \frac{d\Phi}{dt}. \] Substituting this into (8) gives
\[ \int \mathbf{B} \cdot d\mathbf{e} = \mu_0 (I + I_d) = \mu_0 I + \kappa \mu_0 \varepsilon_0 \frac{d\Phi}{dt} \]
(b) $I_d = 4.0 \ A$, again, but \[ \frac{d\Phi}{dt} = \frac{I_d}{\kappa \varepsilon_0} = \frac{4.0}{2 \times 8.85 \times 10^{-12}} = 2.3 \times 10^{11} \ \text{V/m/s} \]

For a medium with dielectric constant $\kappa$ and relative permeability $\kappa_m$, Gauss' Law becomes \( \oint \mathbf{E} \cdot d\mathbf{s} = \frac{Q}{\kappa \varepsilon_0} \) and Maxwell-Ampere's Law becomes
\[ \oint \mathbf{B} \cdot d\mathbf{e} = \kappa_m \mu_0 I + \kappa \mu_0 \varepsilon_0 \frac{d\Phi}{dt} \] so that Maxwell's Equations become:
\[ \oint \mathbf{E} \cdot d\mathbf{s} = \frac{Q}{\kappa \varepsilon_0} \]
\[ \oint \mathbf{B} \cdot d\mathbf{s} = 0 \]
\[ \oint \mathbf{E} \cdot d\mathbf{e} = -\frac{d\Phi}{dt} \]
\[ \oint \mathbf{B} \cdot d\mathbf{e} = \kappa_m \mu_0 I + \kappa \mu_0 \varepsilon_0 \frac{d\Phi}{dt} \]