18.51 In this problem we are given, for a parallel-plate capacitor, its area (3225 $mm^2$), the plate separation (1 mm), and that a material having an $\varepsilon_r$ of 3.5 is positioned between the plates.

(a) We are first asked to compute the capacitance. Combining Equations 18.26 and 18.27, and solving for $C$ yields

$$C = \frac{\varepsilon_r \varepsilon_0 A}{l}$$

$$= \frac{(3.5)(8.85 \times 10^{-12}\ \text{F/m})(3225\ \text{mm}^2)(1\ \text{m}^2/10^6\ \text{mm}^2)}{10^{-3}\ \text{m}}$$

$$= 10^{-10}\ \text{F} = 100\ \text{pF}$$

(b) Now we are asked to compute the electric field that must be applied in order that $2 \times 10^{-8}$ C be stored on each plate. First we need to solve for $V$ in Equation 18.24 as

$$V = \frac{Q}{C} = \frac{2 \times 10^{-8}\ \text{C}}{10^{-10}\ \text{F}} = 200\ \text{V}$$

The electric field $E$ may now be determined using Equation 18.6; thus

$$E = \frac{V}{l} = \frac{200\ \text{V}}{10^{-3}\ \text{m}} = 2.0 \times 10^5\ \text{V/m}$$