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Problem 31.41 (RHK)

Using the result that the plates of a parallel-plate capacitor attract each other with a force given by

$$F = \frac{q^2}{2\varepsilon_0 A} ,$$

we have to show that the force per unit area (*the* ***electrostatic stress***) *acting on either capacitor plate is given by* $\varepsilon_0 E^2/2$. *This result is true, in general, for a conductor of any shape with an electric field* $\vec{E}$ *at its surface.*

Solution:

Let us consider a parallel-plate capacitor of plate area *A*. let the capacitor be charged with charge *q*. The plates attract each other with force

$$F = \frac{q^2}{2\varepsilon_0 A} .$$

Therefore, force per unit area on each plate is

$$F/A = \frac{q^2}{2\varepsilon_0 A^2} \ .$$

Electric field between the plates of a parallel-plate capacitor is

$$E = \frac{q}{\varepsilon_0 A}.$$

Therefore, electrostatic stress on each plate can be expressed by

$$S_E = \frac{\varepsilon_0 E^2}{2}.$$