Answer to Question #82041, Physics / Electromagnetism

A cube of sides length L contains a flat square plate also with sides of length L. The cube and square are in a Cartesian coordinate system. The square is placed at $z = L/2$ and extends from $x = 0\ to\ x = L\ and\ from\ y = 0\ to\ y = L$. The cube is placed such that it extends from $x = 0\ to\ x = L, y = 0\ to\ y = L\ and\ z = 0\ to\ z = L$. The flat square plate has a surface charge density that is given by $-3xy\ (C/m2)$. Calculate the total electric flux passing through the sides of the cube.

Solution.

By Gauss's law, the total electric flux passing through the sides of the cube:

$$\oint EdS = \frac{q}{\varepsilon_0}$$

where q is the charge inside the cube.

So:

$$q = \int_0^L dx \int_0^L (-3xy)dy = -3\int_0^L \frac{xy^2}{2}\bigg|_0^L dx = -\frac{3L^2}{2}\cdot\frac{x^2}{2}\bigg|_0^L = -\frac{3L^4}{4}$$

Answer:

$$\oint EdS = -\frac{3L^4}{4\varepsilon_0}$$