Problem 4.19  Three infinite lines of charge, all parallel to the $z$-axis, are located at the three corners of the kite-shaped arrangement shown in Fig. P4.19. If the two right triangles are symmetrical and of equal corresponding sides, show that the electric field is zero at the origin.

![Figure P4.19: Kite-shaped arrangement of line charges for Problem 4.19.]

Solution: The field due to an infinite line of charge is given by Eq. (4.33). In the present case, the total $E$ at the origin is

$$E = E_1 + E_2 + E_3.$$

The components of $E_1$ and $E_2$ along $\hat{x}$ cancel and their components along $-\hat{y}$ add. Also, $E_3$ is along $\hat{y}$ because the line charge on the $y$-axis is negative. Hence,

$$E = -\hat{y} \frac{2\rho_1 \cos \theta}{2\pi \varepsilon_0 R_1} + \hat{y} \frac{2\rho_1}{2\pi \varepsilon_0 R_2}.$$

But $\cos \theta = R_1/R_2$. Hence,

$$E = -\hat{y} \frac{\rho_1}{\pi \varepsilon_0 R_1} \frac{R_1}{R_2} + \hat{y} \frac{\rho_1}{\pi \varepsilon_0 R_2} = 0.$$