Computation of distributed alternating currents

A numerical (PEEC) approach using the Java programming language.

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Chapter 1 Mutual inductance between conductors with rectangular cross sections

In Figure 1 currents I_1 and I_1 are running perpendicular to the y and z plane and are carried through two conductors with rectangular cross sections. The rectangular areas are bound by the sides A, B, C and D respectively. The conductor axes are located at points (p, q) and (r, s). The conductors are characterized by a coefficient of mutual inductance M, and may be considered as to consist of filament conductors with partial mutual inductance m between individual filaments from one conductor to the other. As an example two coupled filaments are outlined at points (x_1, y_1) and (x_2, y_2) in the figure.

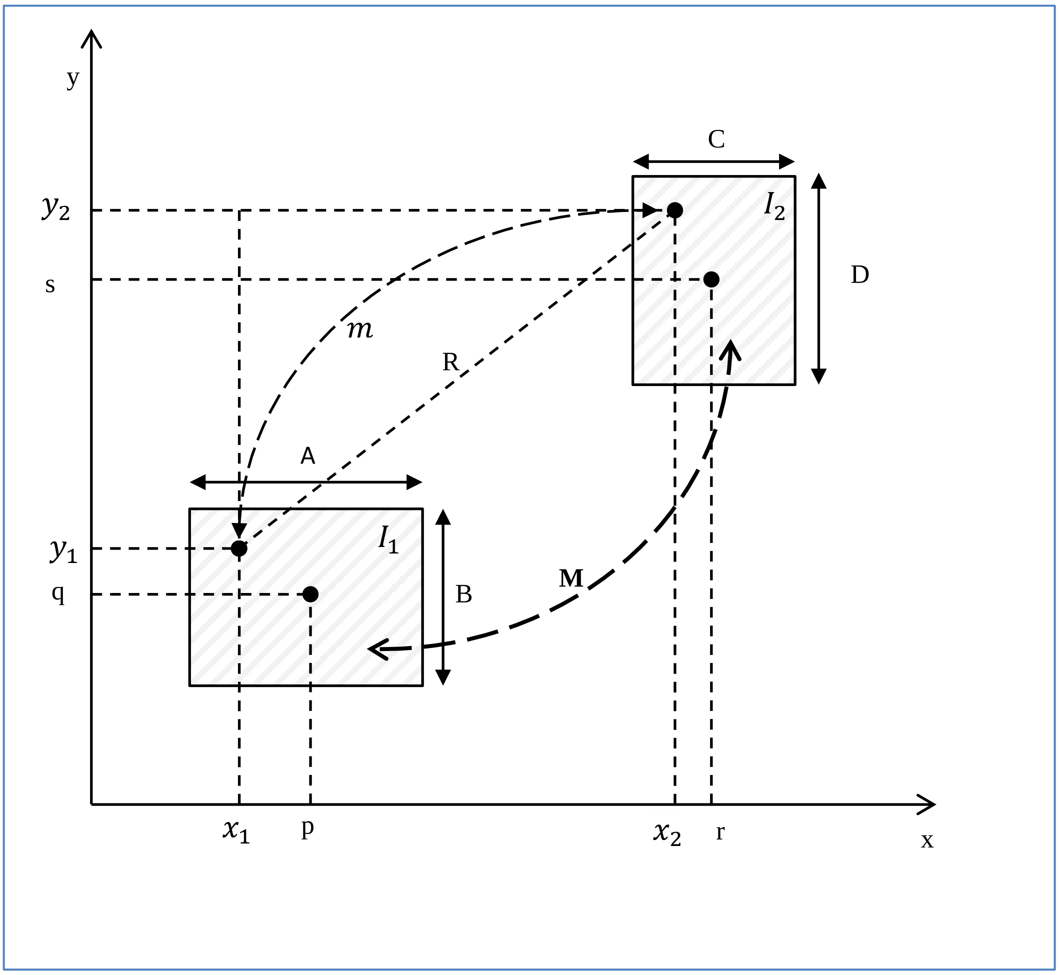

Figure 1 Mutual inductance M between two conductors carrying currents I_1 and I_2 with rectangular cross sections

$$M(p, q, r, s) = \frac{1}{A\,B\,C\,D} \int_{s-\frac{1}{2}D}^{s+\frac{1}{2}D} \int_{r-\frac{1}{2}C}^{r+\frac{1}{2}C} \int_{q-\frac{1}{2}B}^{q+\frac{1}{2}B} \int_{p-\frac{1}{2}A}^{p+\frac{1}{2}A} m(R(x_1, y_1, x_2, y_2))\ dx_1 dy_1 dx_2 dy_2 \tag{1}$$

$$R(x_1, y_1, x_2, y_2) = \sqrt{(y_2 - y_1)^2 + (x_2 - x_1)^2} \quad (2)$$

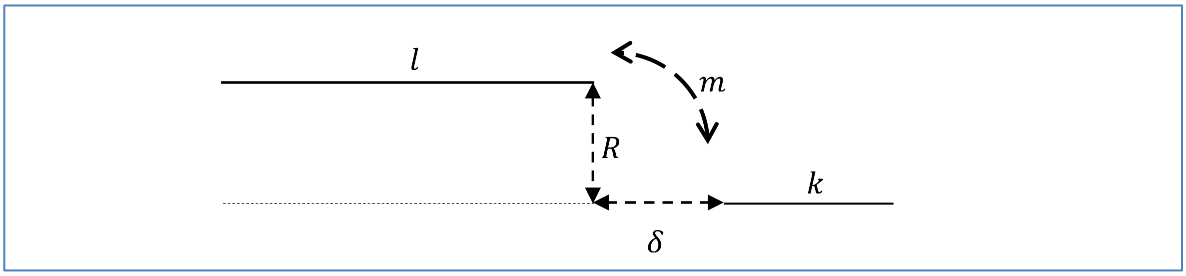

Figure 2 Mutual inductance *m* between two parallel filaments *l* and *k*

Grover, Chapter 6, formula 28:

$$m(R) = \alpha \sinh^{-1}\frac{\alpha}{R} - \beta \sinh^{-1}\frac{\beta}{R} - \gamma \sinh^{-1}\frac{\gamma}{R} + \delta \sinh^{-1}\frac{\delta}{R}$$

$$- \sqrt{\alpha^2 + R^2} + \sqrt{\beta^2 + R^2} + \sqrt{\gamma^2 + R^2} + \sqrt{\delta^2 + R^2} \quad (3)$$

where

$$\alpha = l + m + \delta, \quad \beta = l + \delta, \quad \gamma = m + \delta$$