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| G. binkhorst |
| Computation of distributed alternating currents |
| A numerical (PEEC) approach using the Java programming language. |
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| **Gérard Binkhorst** |
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# General formulation of the mutual inductance between conductors with rectangular cross sections

In Figure 1 currents and are running perpendicular to the x and y 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 and . The conductors are characterized by a coefficient of mutual inductance M, and may be considered to consist of filament conductors with partial mutual inductance between individual filaments from one conductor to the other. As an example two coupled filaments are outlined at points and in the figure.

r

R

y

A

x

C

D

B

p

q

s

**M**

***conductor 2***

***conductor 1***

Figure Mutual inductance M between two conductors carrying currents I1 and I2 with rectangular cross sections

The current flowing through one filament is contained within an area with sides and . Therefore the filement currents in the conductors can be expressed as:

|  |  |
| --- | --- |
| and | () |

The magnetic flux at one filament caused by the current from one other filament, where is the mutual inductance between the filaments at a distance , is given by:

|  |  |
| --- | --- |
|  | () |

The total flux contribution from all filaments in conductor 1 to one filament in conductor 2 can be written as:

|  |  |
| --- | --- |
|  | () |

and the partial mutual inductance between current and one filament in conductor 2:

|  |  |
| --- | --- |
|  | () |

Substituting for from formula (1):

|  |  |
| --- | --- |
|  | (5) |

Which leads to:

|  |  |
| --- | --- |
|  | (6) |

Because of the reciprocity of mutual inductance

equation (6) also represents the mutual inductance between 1 filament in conductor 2 and conductor 1 as a whole. Therefore the flux contribution to conductor 1 from all filaments in conductor 2 can be written as:

|  |  |
| --- | --- |
|  | (7) |

and hence the mutual inductance between all the filaments in conductor 2 and conductor 1:

|  |  |
| --- | --- |
|  | (8) |

Combining equation (6) and (8):

|  |  |
| --- | --- |
|  | (9) |

Substituting for from formula (1):

|  |  |
| --- | --- |
|  | (10) |

Rearranging, converting to integral form, splitting the surface integrals and setting integral limits according to Figure 1:

|  |  |
| --- | --- |
|  | () |

Where it should be noted that is a function of and :

|  |  |
| --- | --- |
|  | () |

# General formulation of the self inductance of a conductor with rectangular cross section

Self induction is a special case in the calculation of mutual induction. Substituting

in equation (11) and (12) and still referring at Figure 1 leads to the co-efficient of self-induction of a conductor with rectangular cross section and sides A and B:

|  |  |
| --- | --- |
|  | (13) |

Equation (12) remains unchanged for the value of R in the integrations:

|  |  |
| --- | --- |
|  | (14) |

# Specific Formulation of the mutual inductance between parallel filaments with shifted positions

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

Grover, Chapter 6, formula 28:

|  |  |
| --- | --- |
| where  , ,  All lenghts in meters, inductance in Henry | () |