

Alternating field simulation with QuickField



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**Director of Marketing and Support
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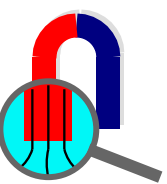
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**Support Engineer
Tera Analysis Ltd.**



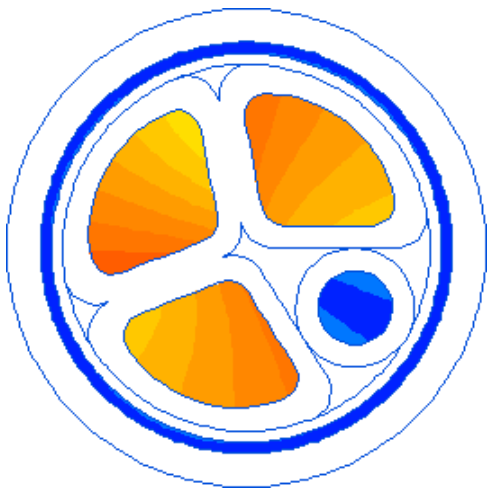
QuickField Analysis Options

Magnetic analysis suite	Magnetostatics
	AC Magnetics
	Transient Magnetic
Electric analysis suite	Electrostatics (2D,3D) and DC Conduction (2D,3D)
	AC Conduction
	Transient Electric field
Thermostructural analysis suite	Steady-State Heat transfer (2D,3D)
	Transient Heat transfer
	Stress analysis



MultiPhysics (2D)

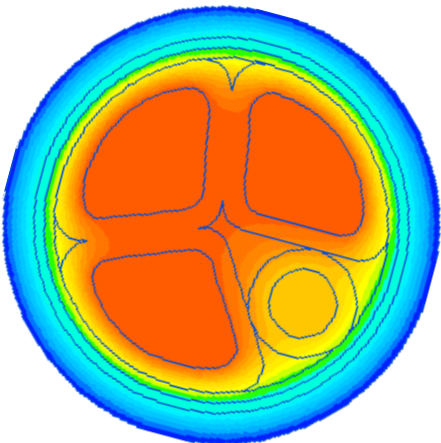
Electromagnetic
fields



Losses

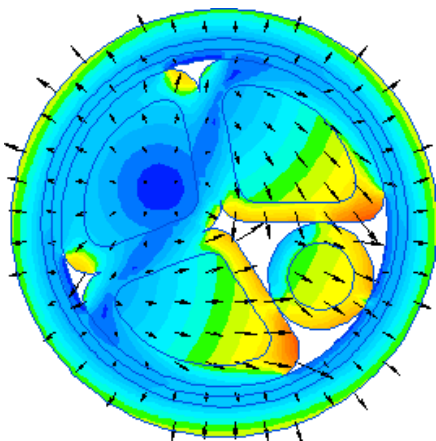


Temperature field



Temperature
field import

**Thermal
Stresses**

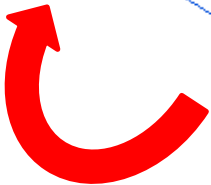


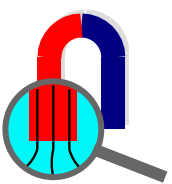
Stresses & Deformations

Forces



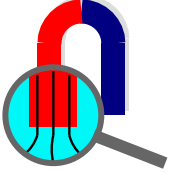
Magnetic state
import



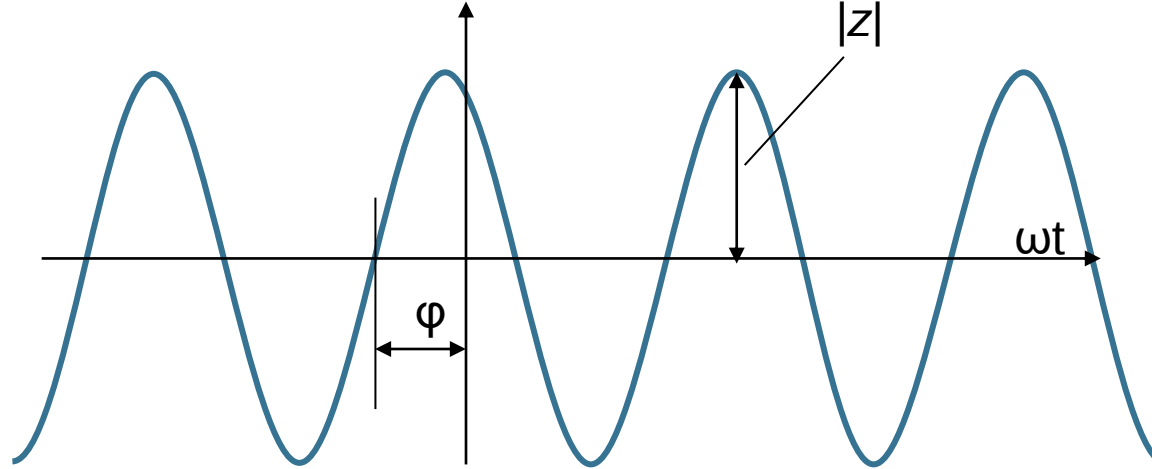


QuickField Analysis Options

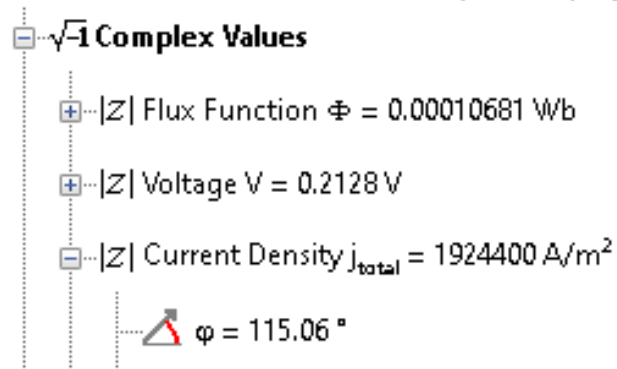
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QuickField AC vs. Transient

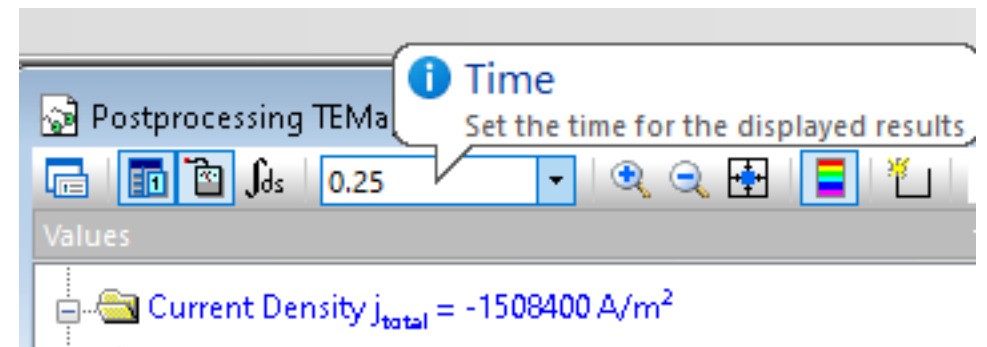


Field components and electric currents are considered to be time-harmonic, vary with time as $z = z_0 \cdot \cos(\omega t + \varphi_z)$, and presented as complex values with real and imaginary parts.

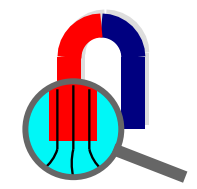


AC

Field sources and boundary conditions can be defined by time-dependent formulae (including time-harmonic), and the transient solution is obtained by time integration using time steps.



Transient



QuickField AC vs. Transient

AC analysis:

Pros:

- Fast, because does not require time integration.

Cons:

- Does not allow analyzing non-linear effects

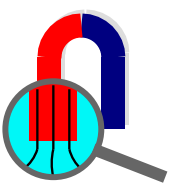
Transient analysis:

Pros:

- No limitations for non-linear material properties

Cons:

- Numerical integration in time domain requires solving of many problems for individual time steps.



QuickField AC vs. Transient

Problem Properties - Motor_c.pbm

General Links

Problem Type: AC Magnetics

Length Units: Millimeters

Model Class:

Frequency: f = 50 Hz

Coordinate System: Polar

Precision: High

L_z = 50 mm

Files

Geometry: Acmotor_c.mod

Data: Motor_c.dhe

Library Data:

Circuit: motor_c.qcr

Specify frequency value

AC

Problem Properties - motor.pbm

General Links Timing

Problem Type: Transient Magnetics

Length Units: Meters

Model Class: Plane-parallel

Coordinate System: Cartesian

Precision: Normal

L_z = 1 m

Files

Geometry: motor.mod

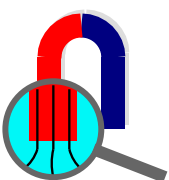
Data: motor.dms

Library Data:

Circuit:

Specify integration time step and final time

Transient



QuickField AC vs. Transient

Block Label Properties - Copper Bar

General Core Loss

Permeability

$\mu_x =$ ☒ Relative ☐ Absolute

$\mu_y =$ ☐ Nonlinear ☐ Anisotropic

Coordinates

☒ Cartesian ☐ Polar

Electrical Conductivity

$\sigma =$ (S/m) ☐ Depends on Temperature

Field Source

$I_0 =$ (A) ☒ Voltage ☐ Total Current

$\varphi =$ (deg) ☒ In Parallel ☐ In Series

Source Mode

Conductor's Connection

Specify phasor magnitude and phase

AC

Block Label Properties - copper

General

Permeability

$\mu_x =$ ☒ Relative ☐ Absolute

$\mu_y =$ ☐ Nonlinear ☐ Anisotropic

Coordinates

☒ Cartesian ☐ Polar

Coercive Force of Magnet

Magnitude: (A/m) ☒ f

Direction: (deg)

Conductivity (for transient analysis only)

$\sigma =$ (S/m) ☐ Depends on Temperature

Temperature: (°C)

Field Source

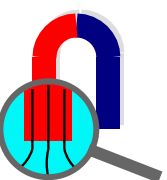
$I_0 =$ (A) ☒ Voltage ☐ Total Current

Conductor's Connection

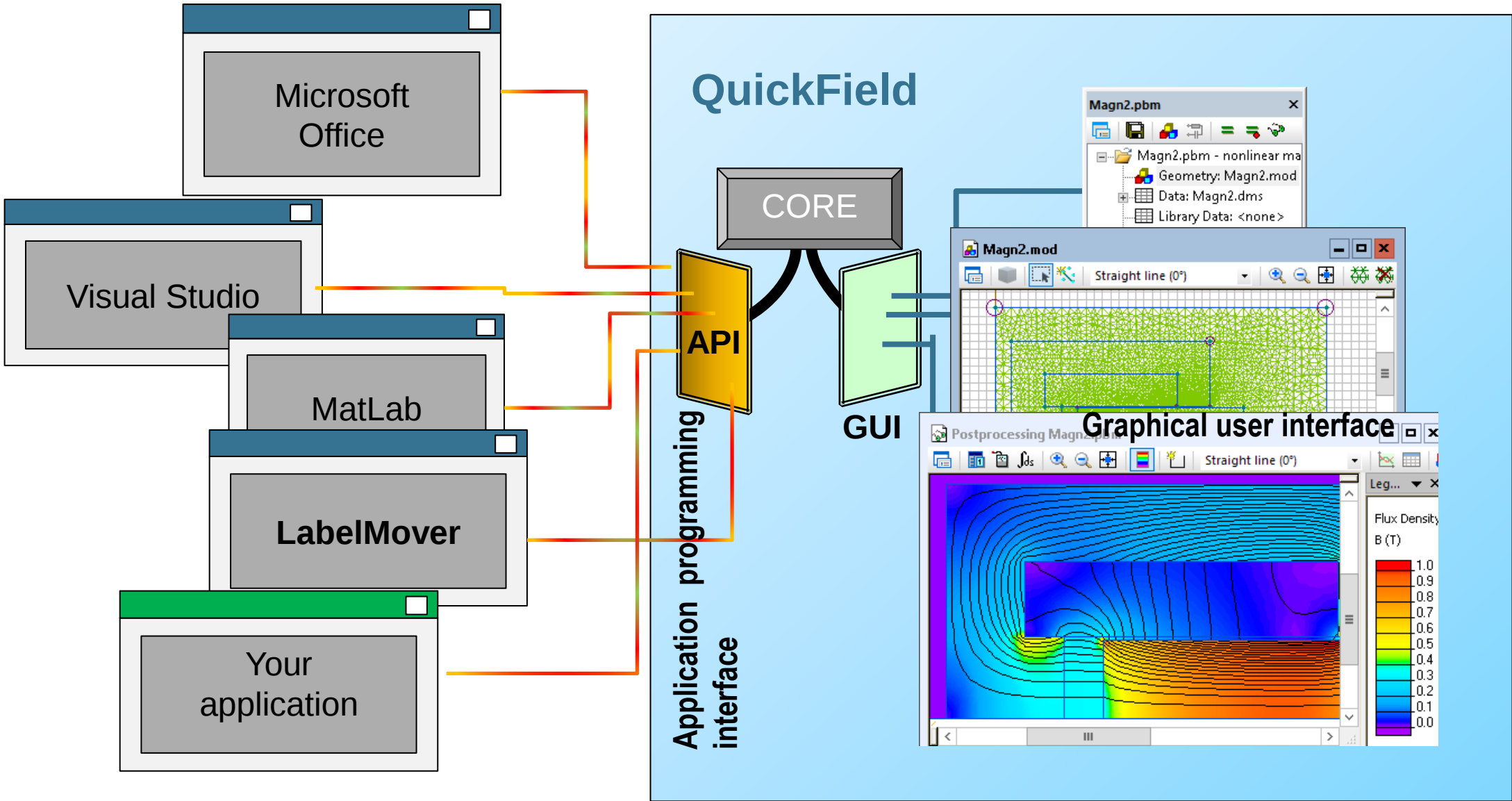
☒ In Parallel ☐ In Series

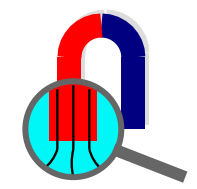
Specify formula of time

Transient



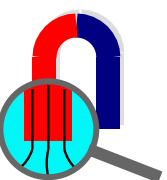
QuickField API



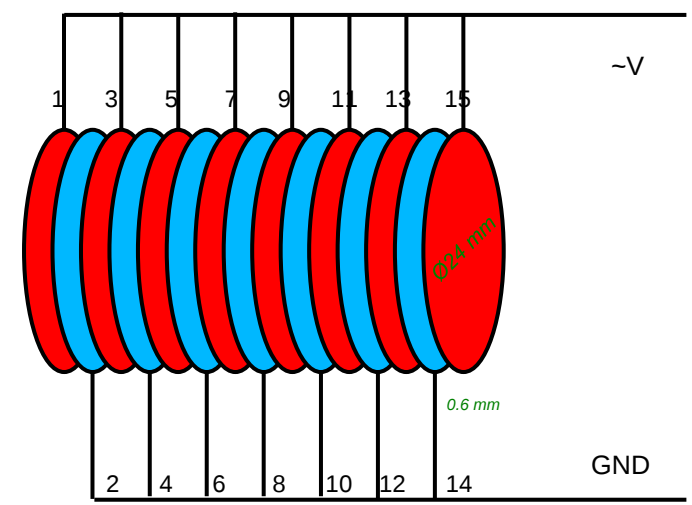
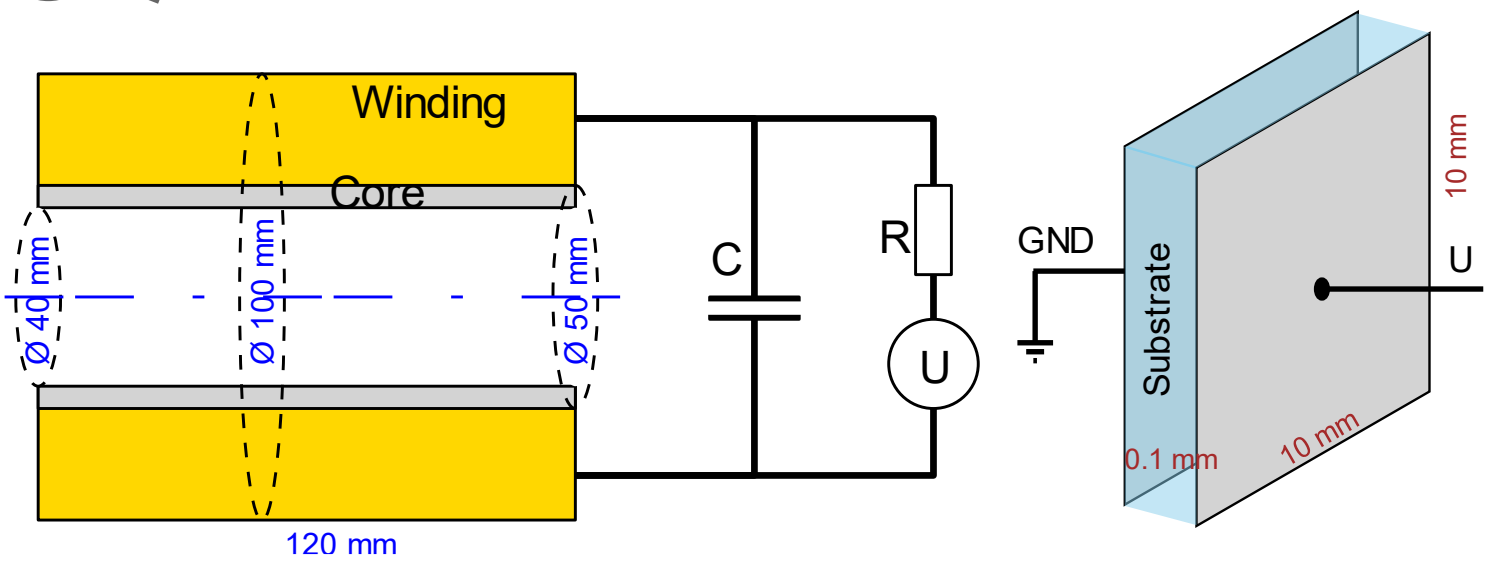


QuickField Difference





Alternating field simulation with QuickField



Coil with ferromagnetic core

Plane capacitor

Nonlinear capacitor

Harmonics analysis

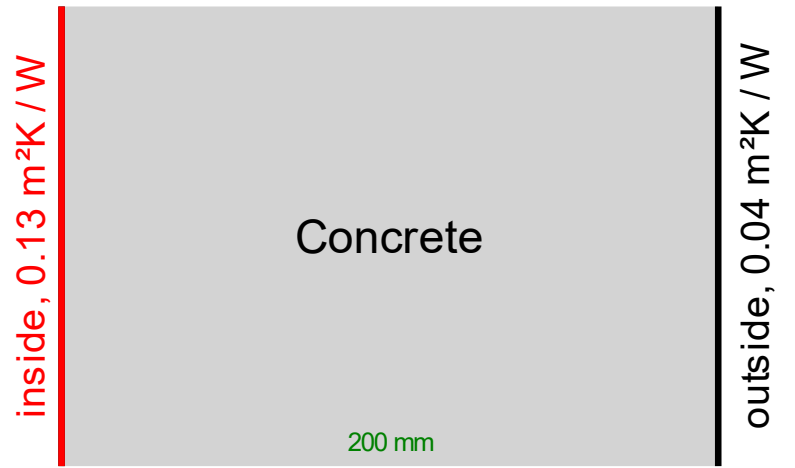
free tool for QuickField, harmonics analysis online, Fourier decomposition

QuickField provides built-in Harmonic analysis utility. However, it works with script that can perform harmonic analysis for input data of any nature. You can

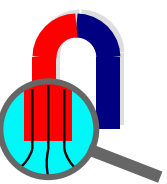
Calculate harmonic of order

Input data: Approximation: $f(t) = A_0 + \sum A_n \cdot \sin(2\pi \cdot k \cdot t / T + \text{phase}_n)$

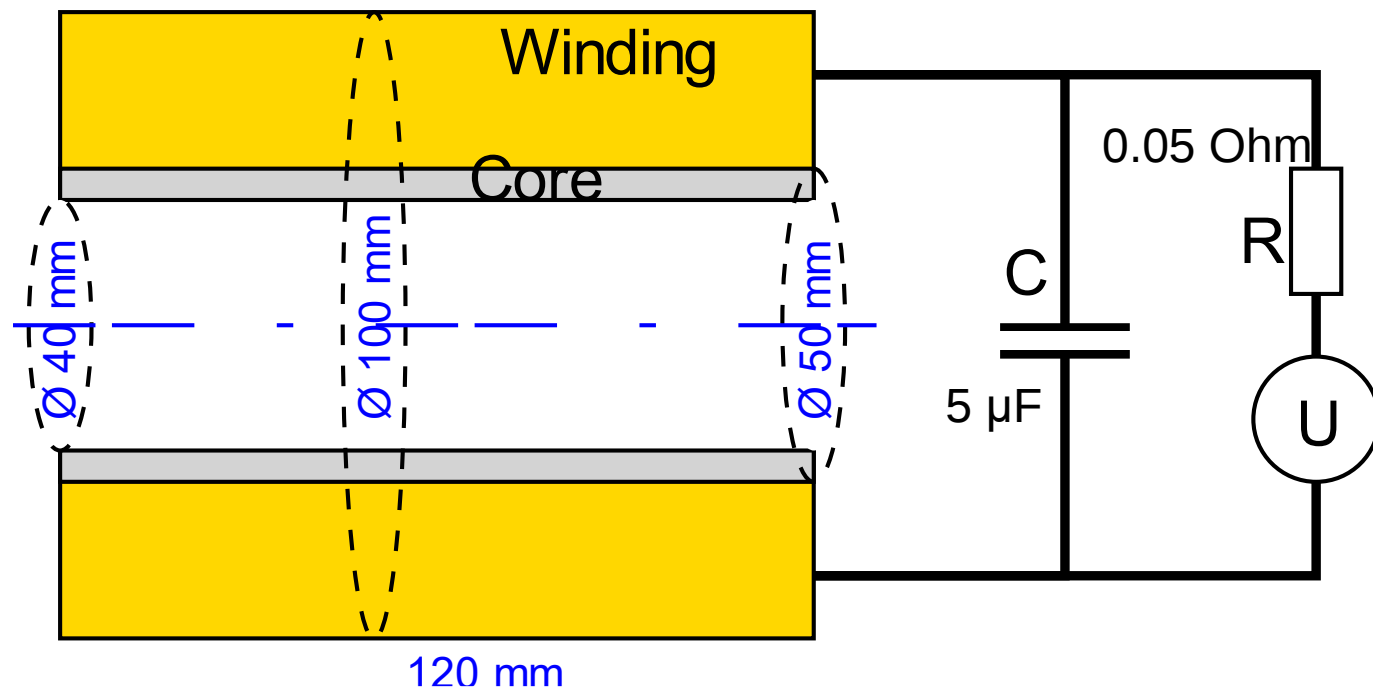
Harmonics analysis



Periodic thermal transmittance



Coil with ferromagnetic core



Task:

Determine current in the winding

Problem specification:

Number of turns $w = 120$

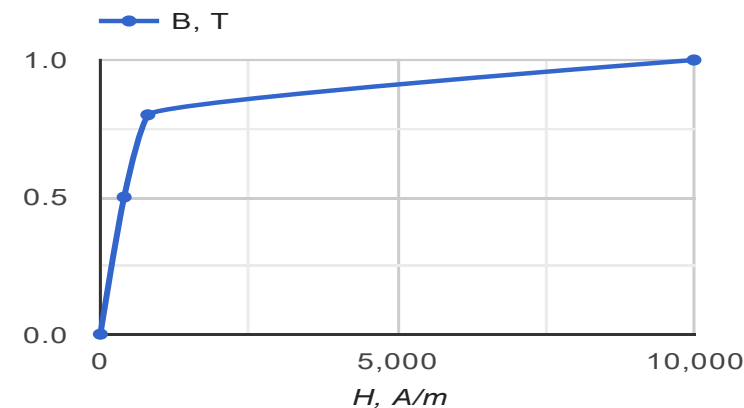
AC voltage value $U = 13.33 \text{ V}$

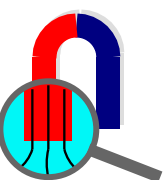
Frequency $f = 50 \text{ Hz}$.

Copper conductivity $g = 56 \text{ MS/m}$;

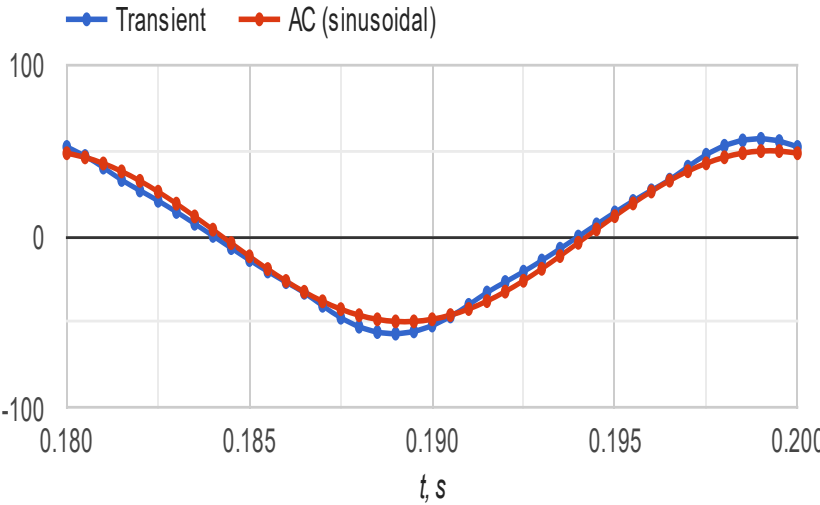
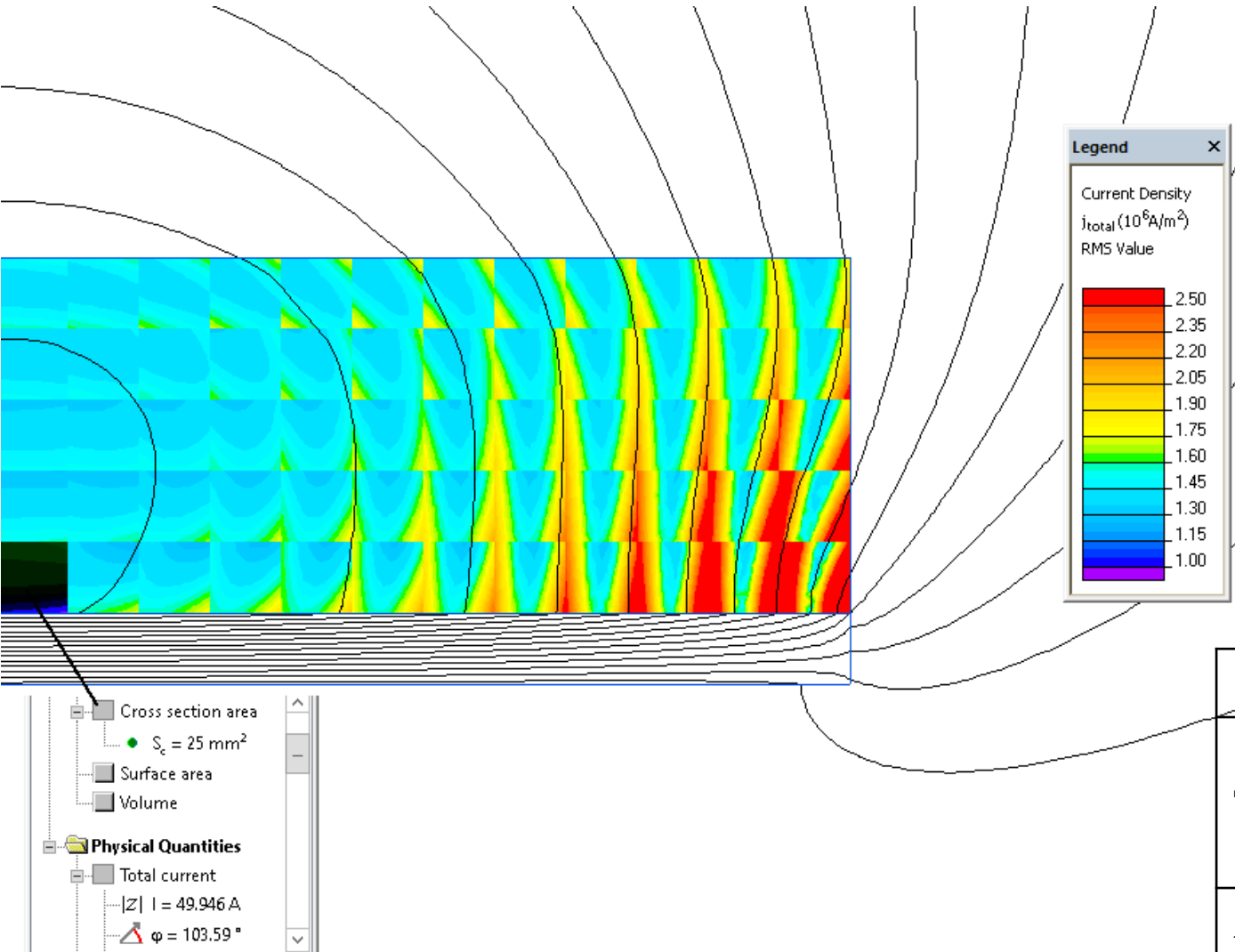
Steel core conductivity $g = 10 \text{ MS/m}$;

Magnetic permeability of the steel core:

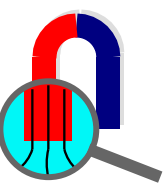




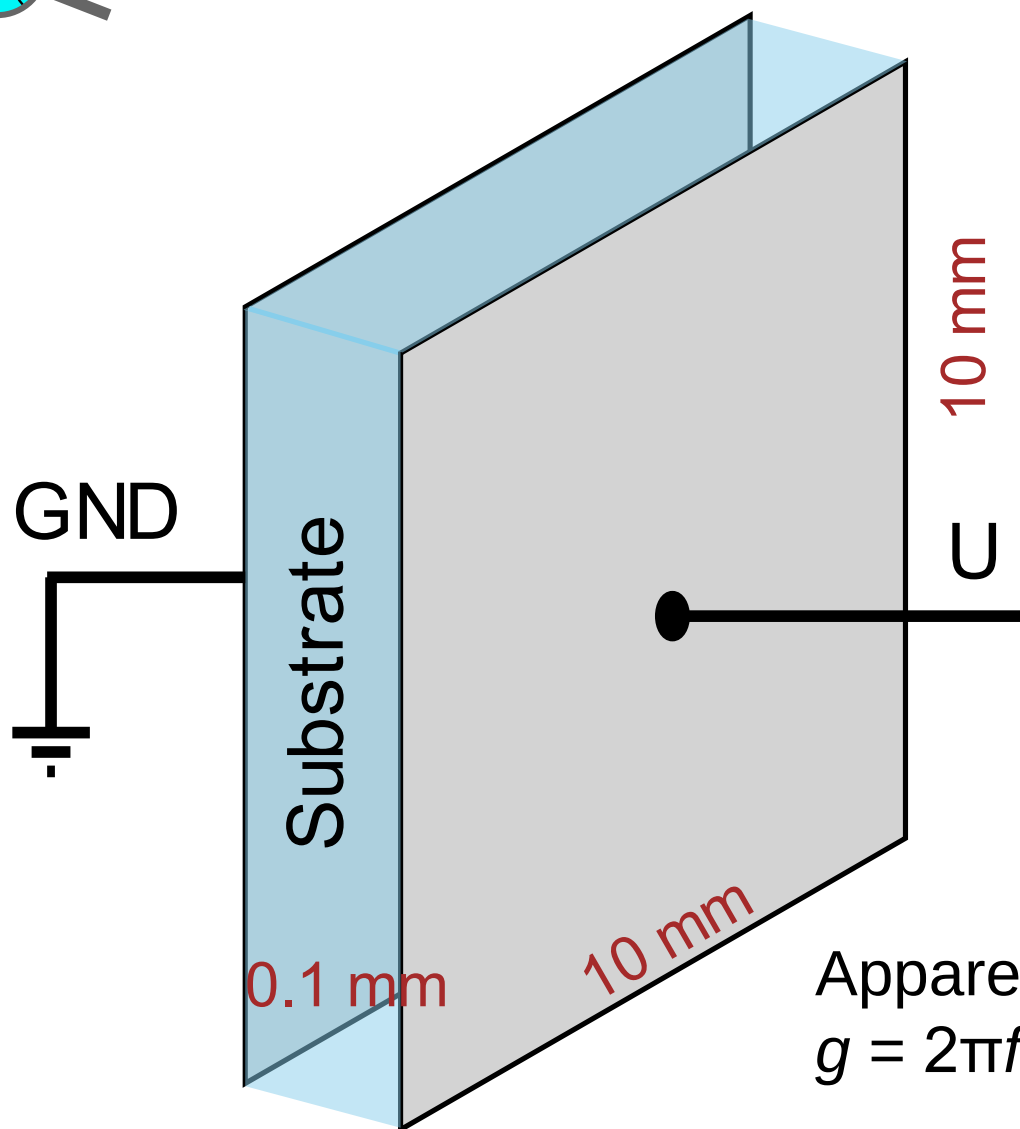
Coil with ferromagnetic core



	Current wave form, A
Transient	$50.5 \cdot \sin(\omega t + 108^\circ) + 5.9 \cdot \sin(3\omega t - 41^\circ) + 3.9 \cdot \sin(5\omega t + 148^\circ)$
AC magnetics	$49.9 \cdot \sin(\omega t + 104^\circ)$



Plane capacitor



Problem specification:

Relative permittivity of substrate $\epsilon = 10$

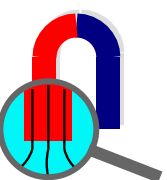
Voltage $U = 5$ V, frequency $f = 1$ MHz

Loss tangent $\tan(\delta) = 0.01$

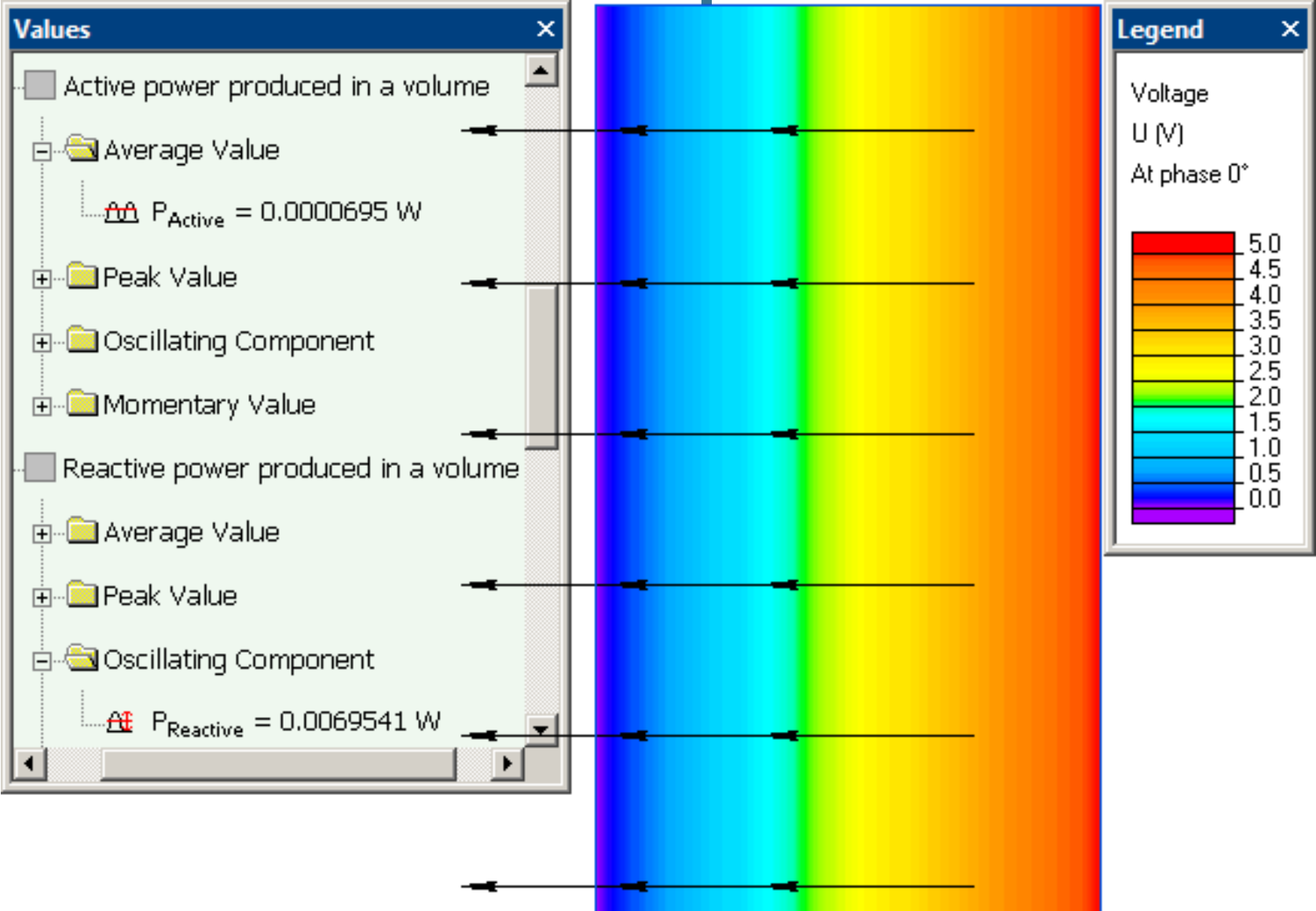
Task:

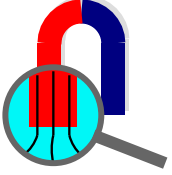
Calculate dielectric loss in the substrate.

Apparent conductivity
$$g = 2\pi f \cdot \epsilon \cdot \epsilon_0 \cdot \tan(\delta)$$

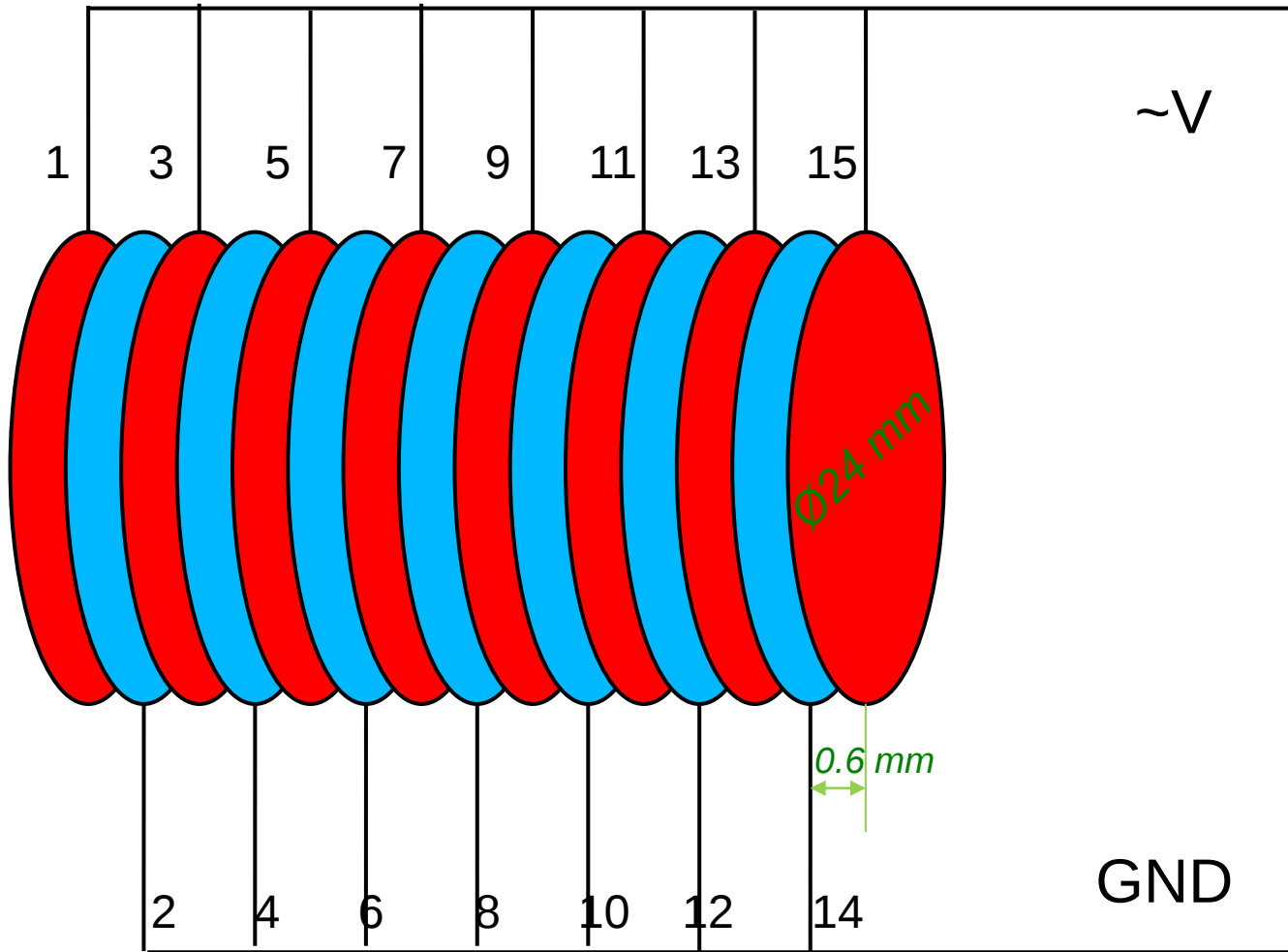


Plane capacitor





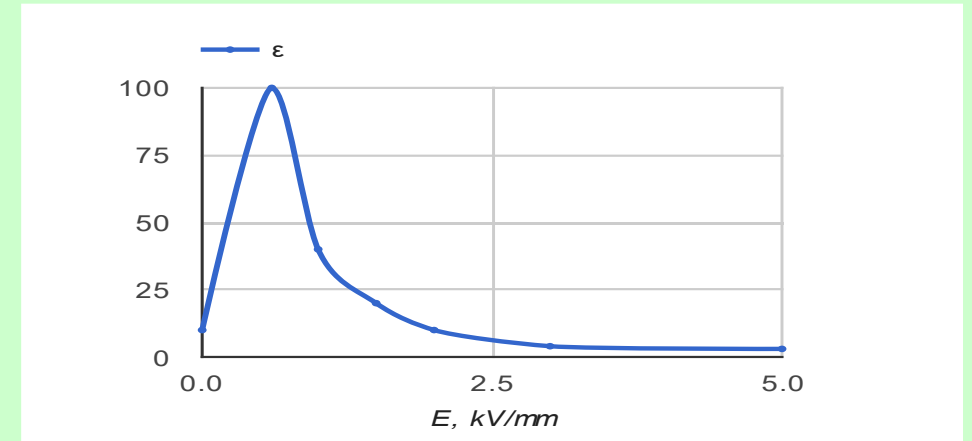
Nonlinear capacitor



Problem specification:

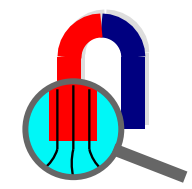
Voltage 240 V , frequency $f = 50 \text{ Hz}$

Relative permittivity ϵ of dielectric material:

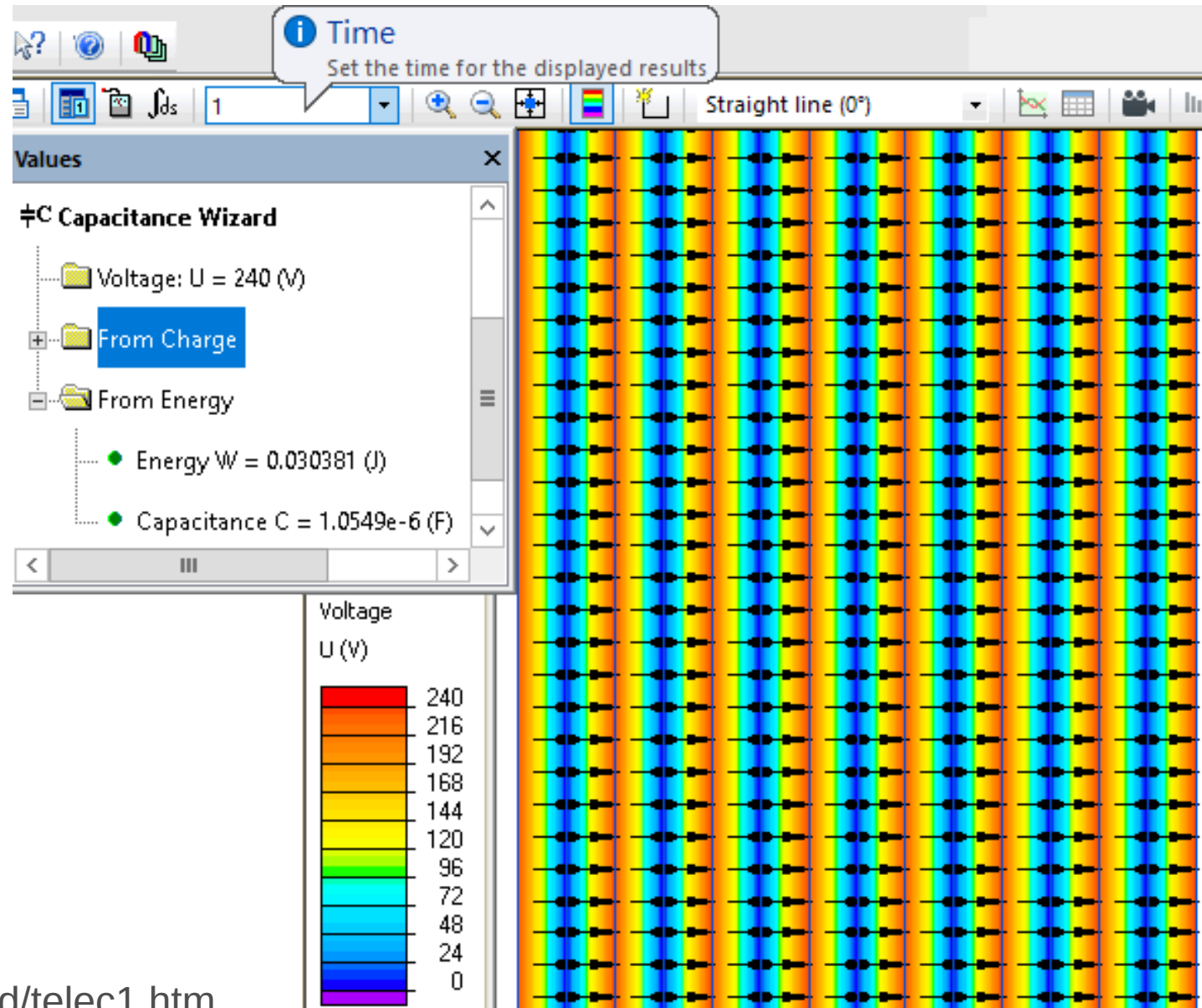


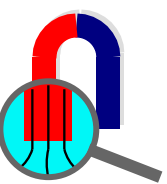
Task:

Calculate current as a function of time.

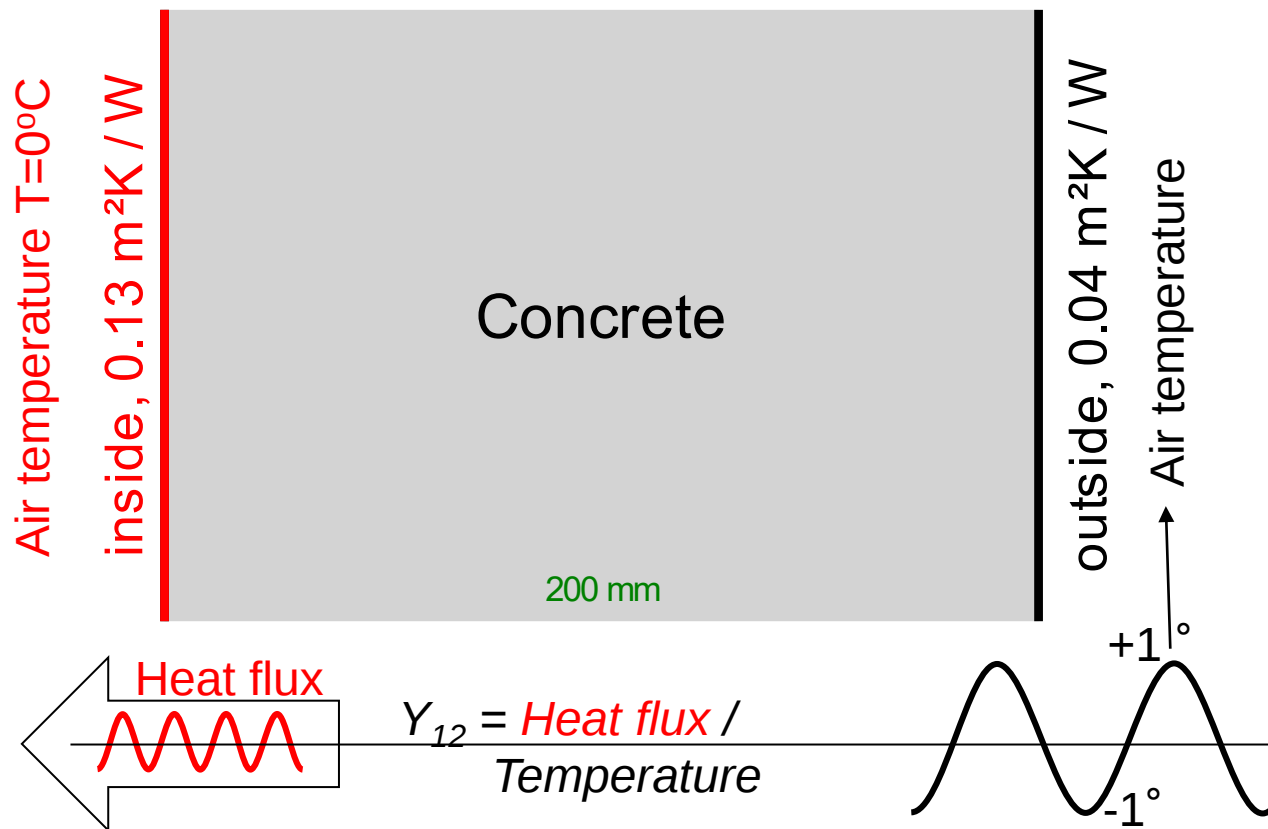


Nonlinear capacitor





ISO 13786-2017. Periodic thermal transmittance



Problem specification:

A homogeneous concrete wall with periodically changing temperature on its surface. Period of thermal variations $T=24$ hours.

Thermal conductivity $\lambda = 1.8 \text{ W/K-m}$

Density $\rho = 2400 \text{ kg/m}^3$

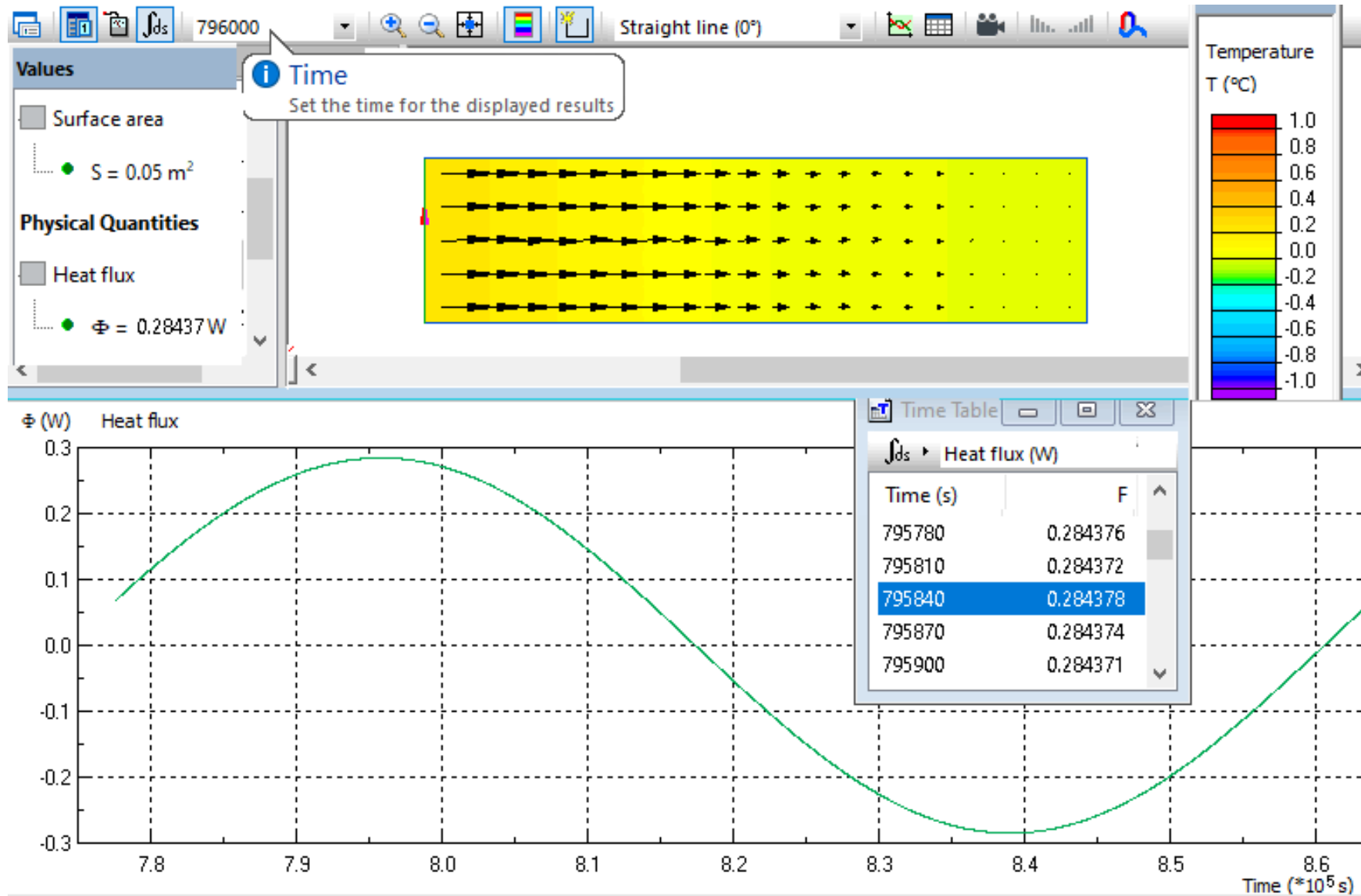
Specific heat capacity $C = 1000 \text{ J/kg-K}$

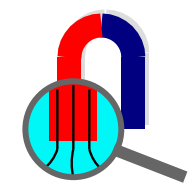
Task:

Calculate periodic thermal transmittance.

Periodic thermal transmittance Y_{12} is amplitude of the density of heat flow rate on one side when the temperature amplitude on that side is zero and there is a unit temperature amplitude on the other side.

ISO 13786-2017. Periodic thermal transmittance





This recording is over

**More recordings and simulation
examples at
www.quickfield.com**

Your feedback is welcome: support@quickfield.com