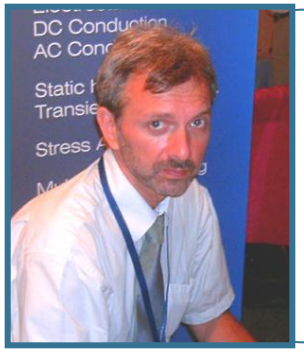
Electromagnetic coils simulation with QuickField



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Director of Marketing and Support,
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Support Engineer,
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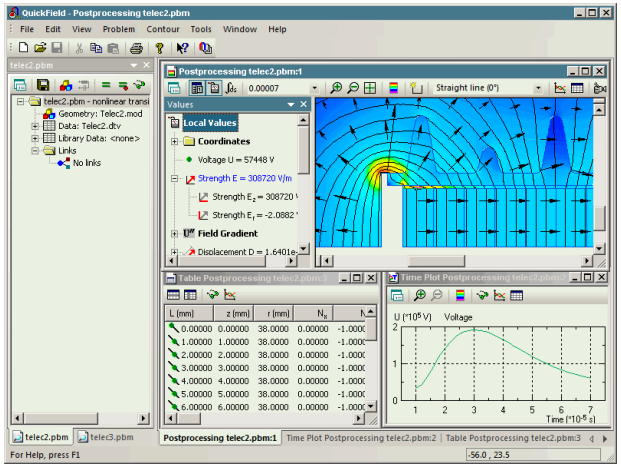
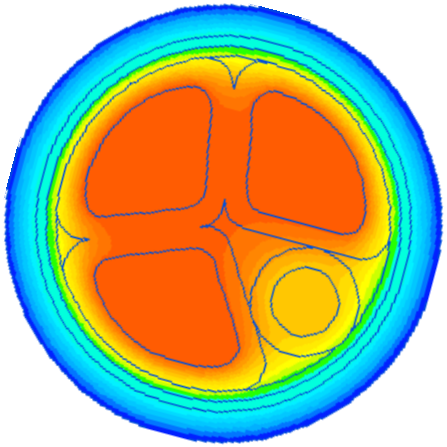
QuickField Analysis Options



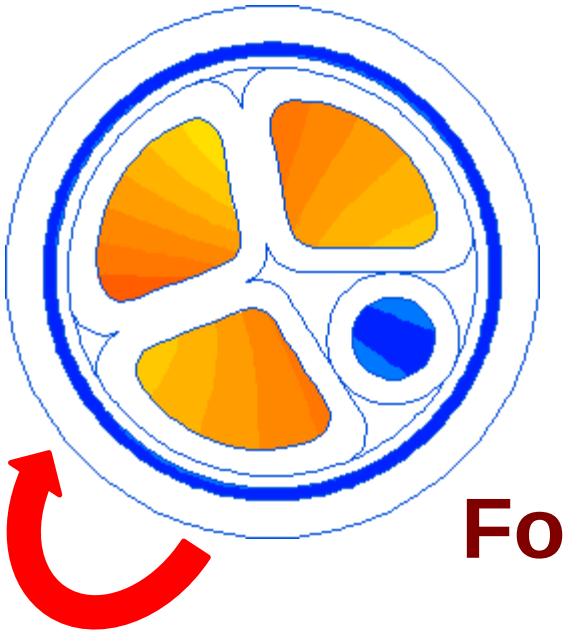
- Magnetic Suite
  - AC Magnetics
  - Transient + DC Magnetics
  - DC Magnetics
- Electric Suite
  - AC conduction + Electrostatics & DC conduction
  - Transient Electric + Electrostatics & DC conduction
  - Electrostatics & DC conduction
- Thermostructural
  - Stress Analysis
  - Transient Heat transfer
  - Steady State Heat transfer

MultiPhysics.

Temperature Field

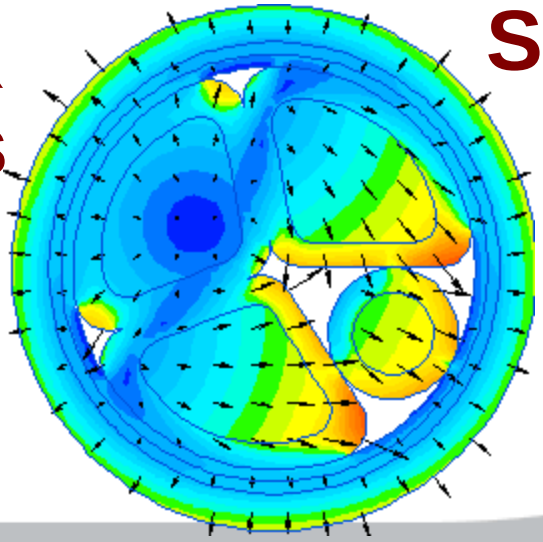


Electromagnetic fields



Thermal Stresses

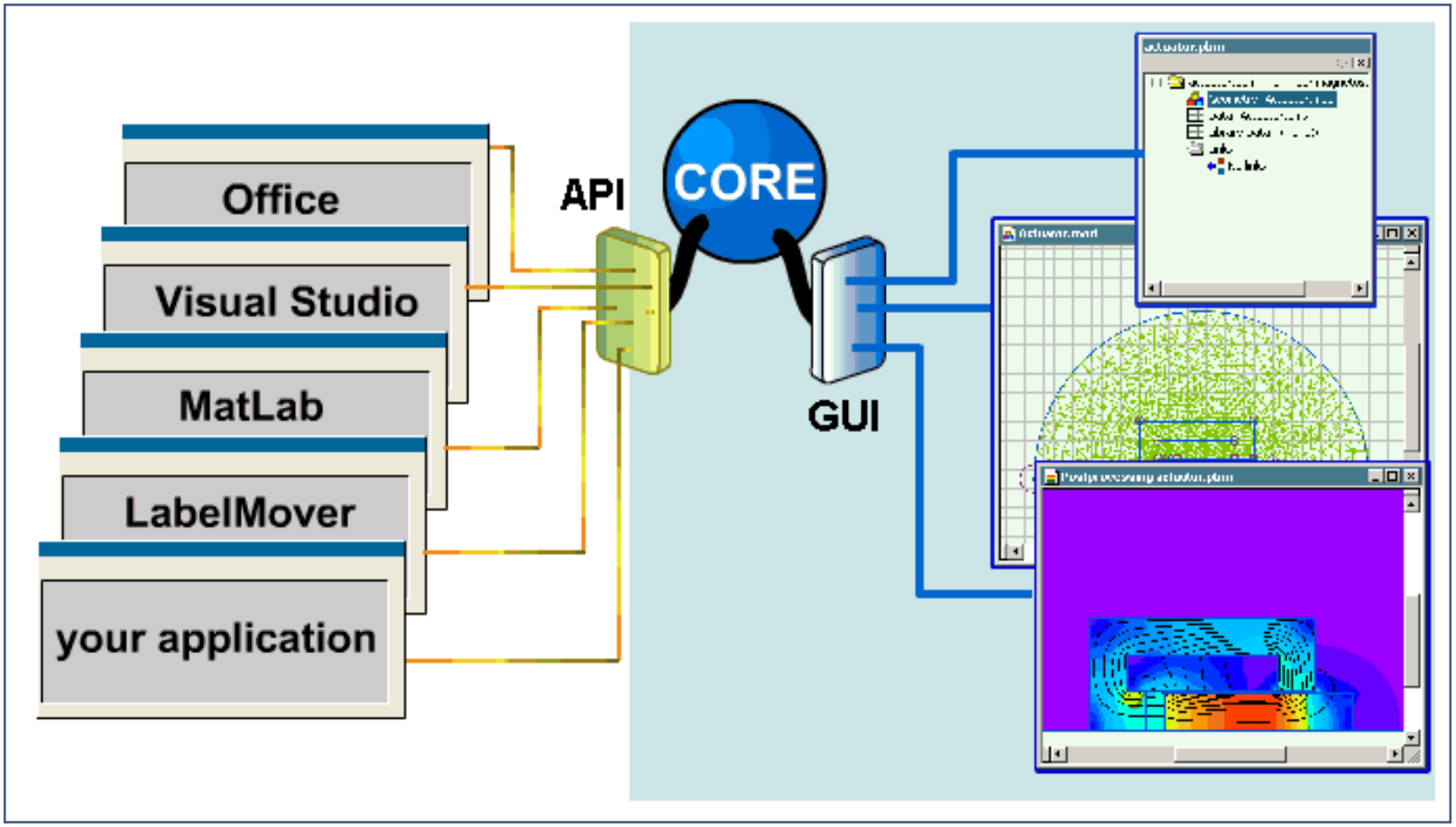
Forces



Magnetic state import

Stresses & Deformations

Open object interface

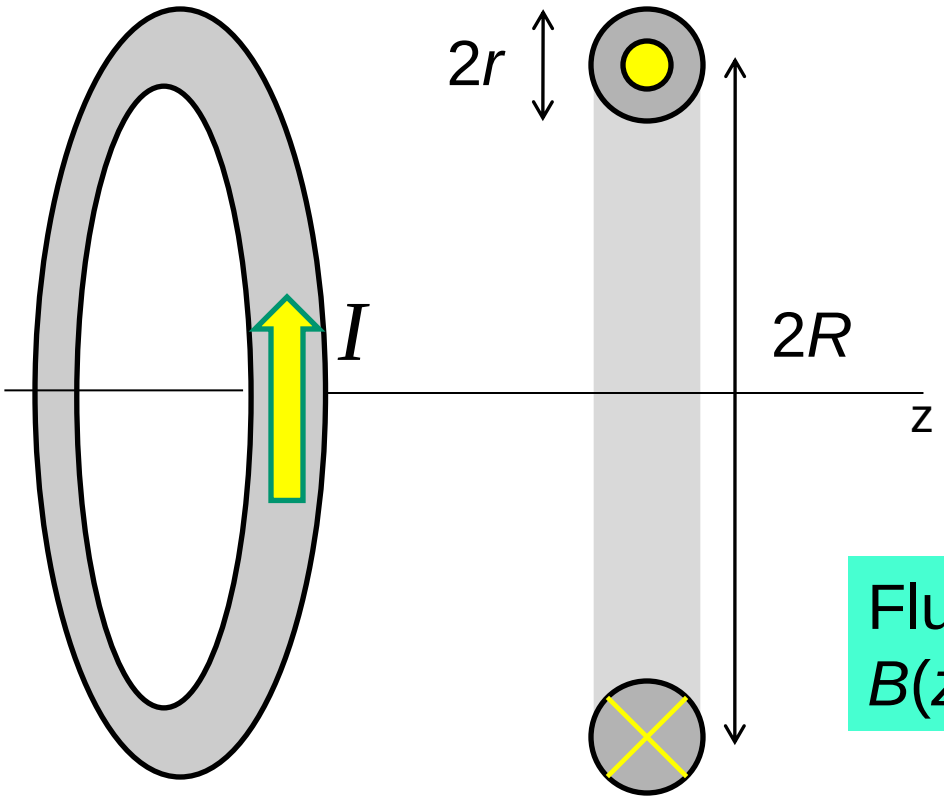


QuickField Difference

Electromagnetic coils simulation with QuickField

1. One-turn loop
2. Multi-turn winding.
3. Special coils: Helmholtz coil, Maxwell coil, Brooks coil.
4. Coil with electric circuit
5. Coil heating
6. Coil stress
7. Coil dynamics

One turn loop



Problem specification:

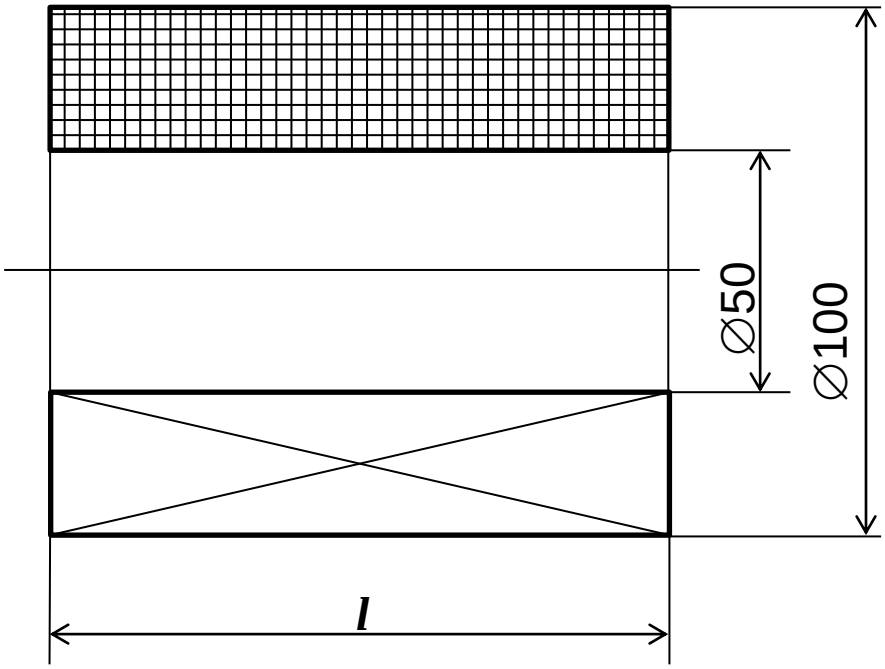
Current I = 1 A
Ring radius R = 100 mm
Wire radius r = 2 mm

Flux density on the axis ($r<<R$)

$$B(z) = \mu_0/4\pi * I * 2\pi R^2/(z^2+R^2)^{3/2}$$

http://www.quickfield.com/advanced/one_turn_loop_inductance.htm

Multi-turn coil (solenoid)



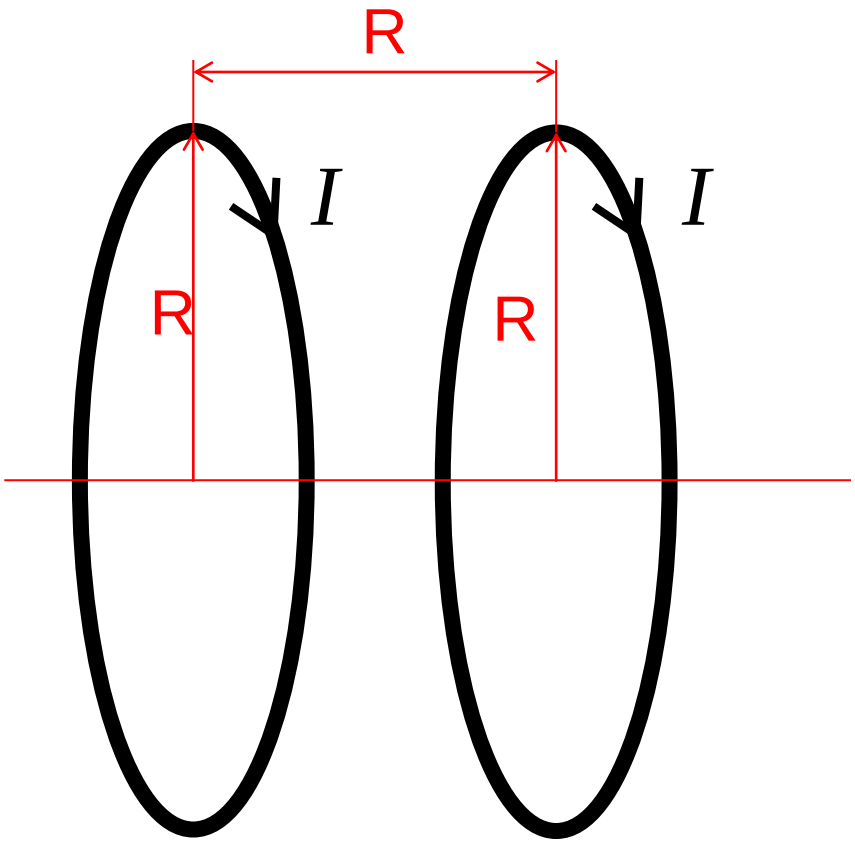
Problem specification:

Number of turns
N = 7500
Solenoid length
l = 300 mm

Flux density inside:
$B = \mu_0 * I * N / l$

http://www.quickfield.com/advanced/toe_lab5.htm

Helmholtz coil



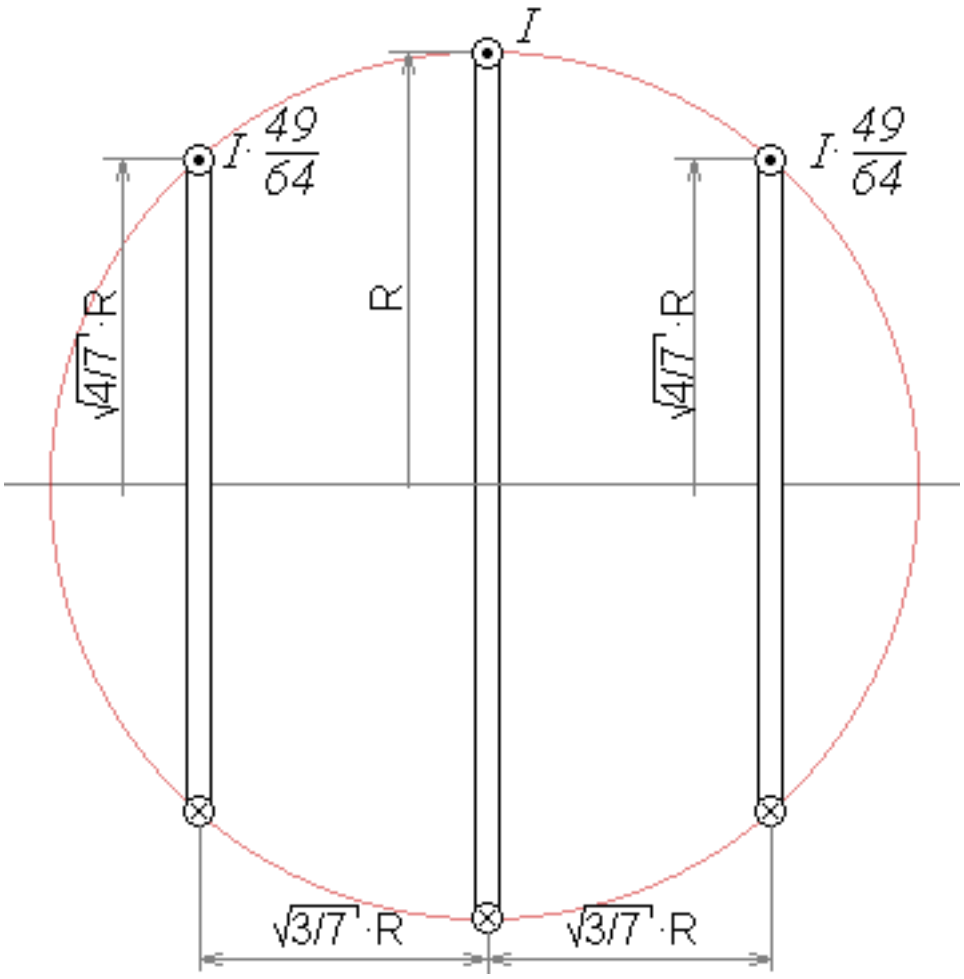
Problem specification:

Current I = 1 A,
Coil radius R = 1 m,

Flux density in the center
$B = (0.8)^{3/2} * \mu_0 * I / R$

http://www.quickfield.com/advanced/helmholtz_coil.htm

Maxwell coil



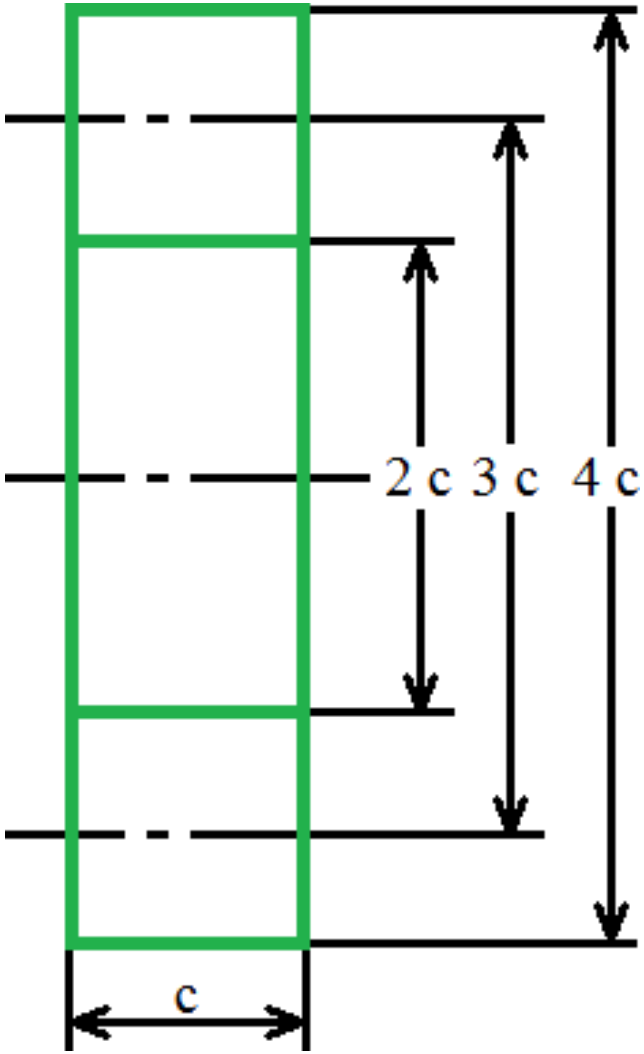
Problem specification:

Current I = 1 A,
Coil radius R = 1 m,

Flux density in the center
$B = (15/16) * \mu_0 * I / R$

http://www.quickfield.com/advanced/maxwell_coils.htm

Brooks coil



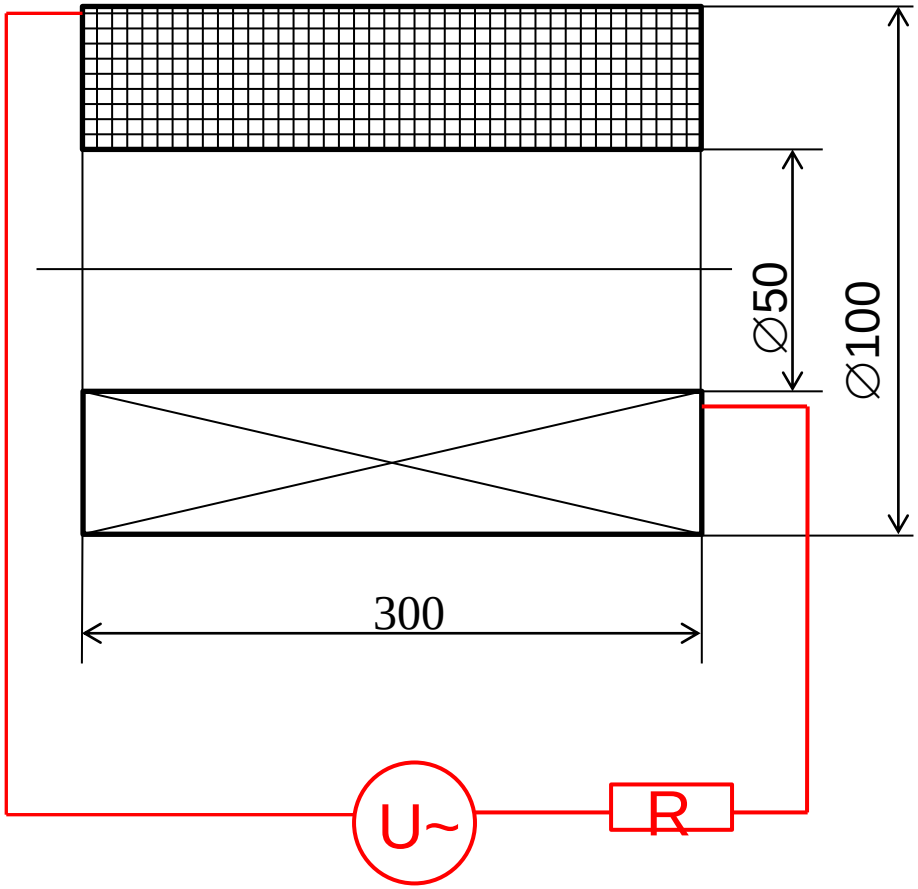
Problem specification:

Current I = 1 A,
Number of turns N = 200,
c = 20 mm.

Inductance L = (Flux / I)* N^2

http://www.quickfield.com/advanced/brooks_inductor.htm

Coil in electric circuit

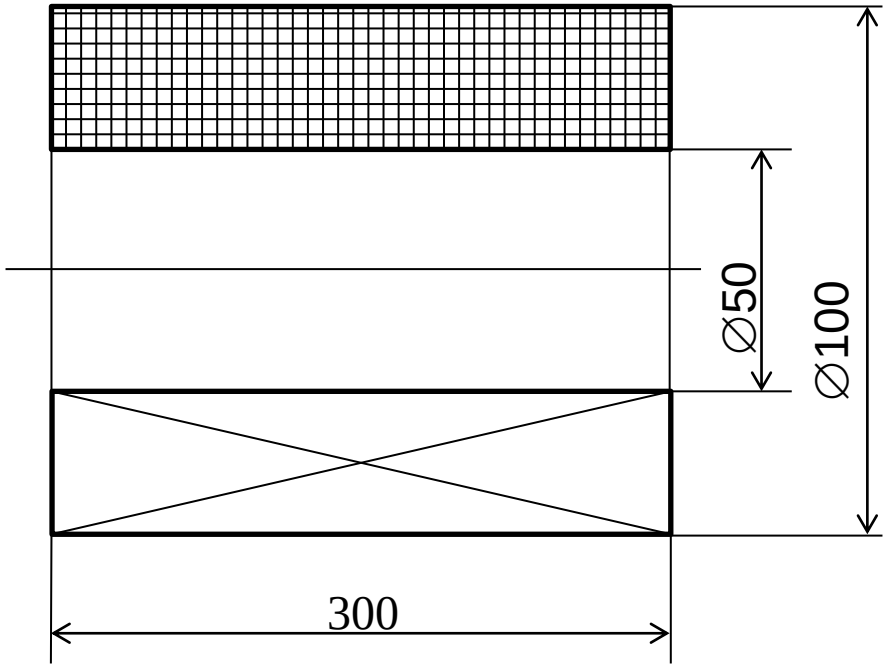


Problem specification:

Voltage U = 220 V,
Resistance R = 10 Ohm,
Frequency f = 50 Hz.
Conductivity g = 56e6 S/m
Number of turns N = 7500

Coil current
$\boldsymbol{I} = U / (r + j*2\pi f*L)$
Active power
$P = U \cdot \boldsymbol{I}^*$

Coil heating

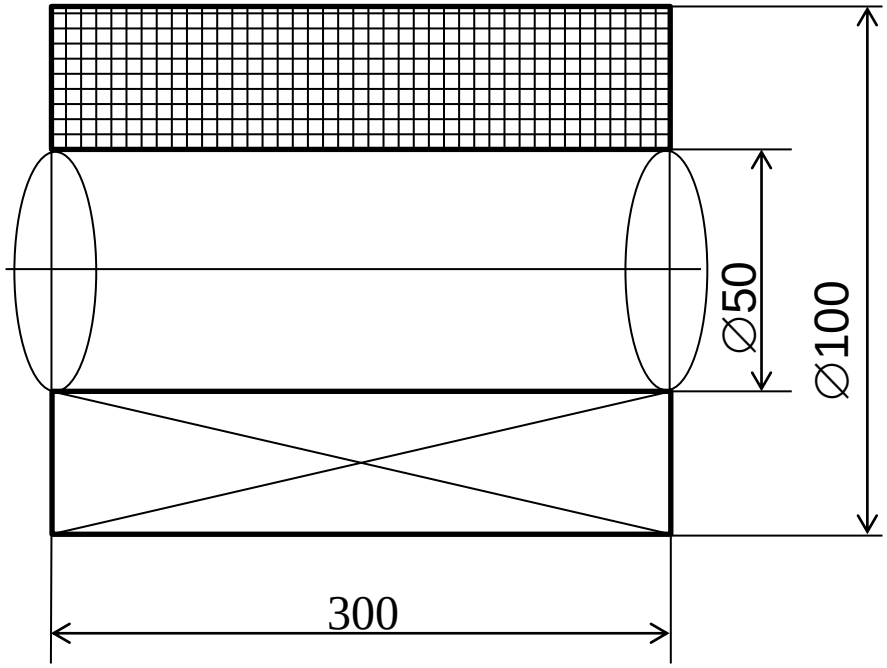


Problem specification:

Ambient temperature
T_0= 20 ˚C.
Convection coefficient
α = 10 W/K*m^2

Volume power
W = Power / Volume

Coil stress

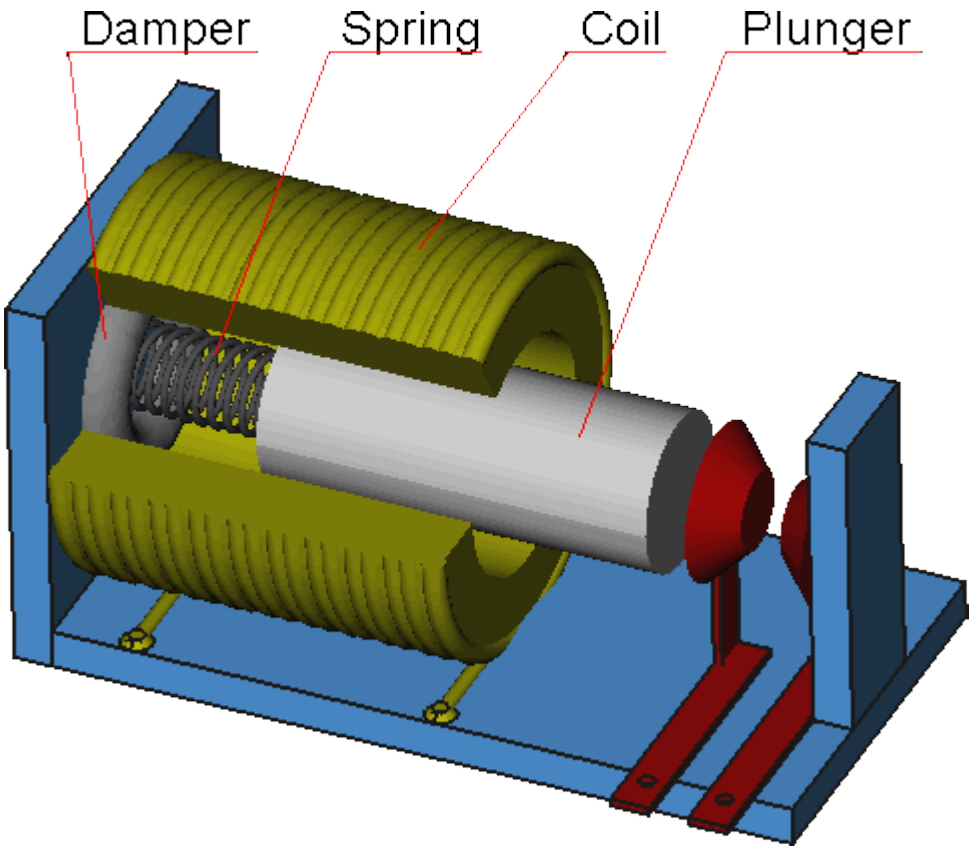


Problem specification:

Young module
E = 17 MPa
Thermal expansion coefficient
α = 16.6e-6 K^{-1}

Coil stress caused by Ampere force F_r and heating

Coil dynamics



Problem specification:

Current I = 0.2 A.
Number of turns N=2000

Plunger position $x(t)$