

# Worksheet for Magnetic Fields

Pierre-André Chevalier, Andreas Stahel, Phoebe Hoidn Ubertini

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## 1 Goals

The main goal of this lab is the visualization of magnetic fields of a circular conductor with the help of *Octave* or **MATLAB**.

## 2 Files and Code

Find code on the web page `staff.ti.bfh.ch/sha1` using the link `schedule` and then section *Files for the Lab Sessions*.

Find the information for this lab in the directory `F2/BiotSavart`. The main results are presented in the file *BiotSavart.pdf*.

## 3 Integration with *Octave*

- 1 Start up *Octave* and your favourite text editor. Copy the code below into a file `testIntegration.m` and verify that *Octave* computes the correct integral

$$\int_0^{\pi} 2 \sin(x) dx = 4$$

- 2 Read the second example below on how an anonymous function is used to compute

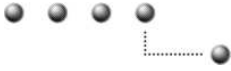
$$\int_0^1 \sin(px 2\pi) dx$$

for a given value of the parameter  $p$ .

- 3 Write some *Octave* code to compute the integral

$$\int_0^{2\pi} \frac{\cos \phi}{\sqrt{2 - e^{-\phi} \cos^2 \phi}} d\phi$$

- 4 Make sure that you find the *Octave* files listed in Table 1 on page 12 of the notes *Biot-Savart and Helmholtz Coils* on the system.



**Octave**

```
% perform a numerical integration
1; % dummy command to enforce a script file
function y=myfunc(x)
    y=2*sin(x);
endfunction
```

```
integral=quad('myfunc',0,pi)
```

**Octave**

```
%% integration using an anonymous function
p = 2; % value of parameter
```

```
function y=f(x,p) % function to be integrated with respect to x
    y=sin(p*x*2*pi);
endfunction
```

```
quad(@(x)f(x,p),0,1) % in p is an integer number, then the exact value is 0
```

### 4 From Biot–Savart to Helmholtz

- 1 Read and understand the code of the functions `dHx.m`, `dHz.m` and the integration for the  $x$  and  $z$  component of the magnetic field  $\vec{H}$  mentioned in Section 3.2 The Helmholtz configuration in the notes. Make sure you understand the connection to equation (2).
- 2 Compute the  $z$  component  $H_z$  along the  $z$  axis and generate a graph similar to Figure 4 .
- 3 Write code to generate Figure 5 for the Helmholtz configuration.

### 5 Visualization of Magnetic Vector Fields

- 1 Read and understand Section 3.4 Field in the  $xz$ -plane in the notes. Assure that you understand the result shown in Figure 7.
- 2 Generate the vector field plot for the Helmholtz configuration.
- 3 Read and understand the methods in Section 3.2 on how to measure homogeneity of a vector field.
- 4 Examine the relative error of  $H_z$ , as shown in Figure 9 on a larger domain.
- 5 Reapply the methods in Section 3.2 to a configuration different from the optimal Helmholtz configuration, i.e. the distance between the two coils is different from the radius  $R$ . Compare the results to Figure 11.