Worksheet for Magnetic Fields

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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 you 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 ☐

$$\int_0^1 \sin(p\,x\,2\,\pi)\;dx$$

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. ☐