# Lab 7: Filters

## Preamble

### Other formats

This document is available in HTML (https://cpjobling.github.io/eg-247-textbook/labs/lab07/index) format for online viewing and as PDF (https://cpjobling.github.io/eg-247-textbook/labs/lab07/lab07.pdf) for printing.

### Acknowledgements

This lab is based on Filter Design Using Matlab Demo by David Dorran (http://dadorran.wordpress.com/2013/10/18/filter-design-using-matlab-demo/).

There is a YouTube video (http://www.youtube.com/watch?v=vfH5r4cKukg&list=PLJ8LTUMGG9U4vAGind2_Bh4TUfgg1y0F4&feature=share&index=2) that illustrates what we are going to be using.

## Aims

This optional lab exercise demonstrates the design and simulation of digital filters. I is not assessed, but you may find it useful preparation for the project.

# Setup

## Before you start

If you haven't already, create a suitable folder structure on your file-store for your labs.

I suggest

```
P:\workspace
    signals-and-systems-lab
        lab01
        lab02
        lab03
        lab04
        lab05
        lab06
        lab07
        :
```

Use folder `p:\workspace\signals-and-systems-lab\lab07` for this lab.

## Preparation

Download the example filter design script filters.m (https://github.com/cpjobling/eg-247-textbook/blob/master/portfolio/lab07/filters.m) from this repository. Save it to your folder for `lab07`.

Open the script as a MATLAB Live Script and execute the embedded code step-by step and read and understand the commentary.

# Lab Exercise

## Lab Exercise 15: Interactive Filter Design

MATLAB provides a filter design tool with a graphical user interface called `fdatool`.

We want you to use this tool to design and test a low-pass, band-pass and high-pass Butterworth filter with sampling frequency equal to 44.1 kHz. The filter should implement the first, second and third stage in a three-stage graphic equalizer with a low pass filter with a cut-off frequency of 31.5 Hz, a pass-band filter for the middle filter ($f_1$ to $f_2$) of about one octave and centre-frequency fc equal to 63 hz and a high-pass filter with pass-frequency of 125 Hz.

The aim of this exercise is to determine the order of the Butterworth filters to be used in your design and the Q factor needed (where $Q = f_c / (f_2 - f_1)$) for the pass-band filters required to implement the mid-range of your 10-stage graphic equalizer.

The centre pass-band filter should be designed so that $f_2$ & $f_1$ satisfies $f_c = (f_1 f_2)^{1/2}$. Your goal is to find the $\Delta f$ value for this filter that achieves a flat frequency response when it is combined with equal weight to the low-pass and high-pass filters.