# Stochastic Methods Lab

## Assignment Sheet 3

### Due on October 4, 2022

*Note:* The work is to be submitted via `git`, as discussed in class. The coding language is Python. Please make sure that your code actually runs and produces the requested output. Please make your code readable for the instructor and TA, and include comments wherever necessary. Please submit .py source code, not jupyter notebooks. Theoretical questions may be submitted as a scan of handwritten notes or typed up (e.g., using LaTeX). The submission deadline is midnight of the stated due date.

## Problem 1 [4 points]

Suppose you want to immunize a liability at time $D$ with two bonds of Macaulay durations $D_1$ and $D_2$, respectively. Show that the fraction $\omega_1$ and $\omega_2$ of the two bonds in the initial portfolio need to satisfy

$$\omega_1 + \omega_2 = 1\,,$$
$$\omega_1\,D_1 + \omega_2\,D_2 = D\,.$$

## Problem 2 [7 points]

The ECB publishes spot rate data (look for "Euro area yield curves") in a downloadable CSV file. Look for the latest release and briefly discuss what kind of data you find in the file. Remember from class how to read CSV files in python (or find additional online documentation), read in the ECB spot rates from the CSV file, and plot the yield curve.

## Problem 3 [3 points]

Implement the payoff functions for a European call option and a European put option, and plot them for a strike price of 100 \$.

## Problem 4 [4 points]

Find a linear combination of European put and call options which reproduces the following payoff graph, called the butterfly spread:

**Butterfly Spread**
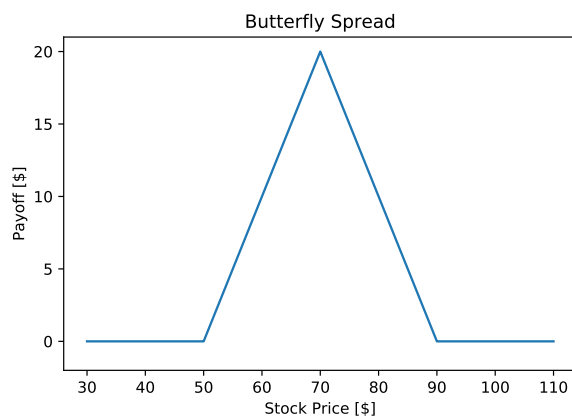
## Problem 5 [2 points]

In class, we analyzed how to price an option for a binary model of stock prices with one time step. Would a similar analysis work if we allowed the stock to have three possible values in the future instead of just two? Explain your answer.