1. The formula for the zero coupon is \( P = 1/(1+y/2)^{2N} \). Hence we obtain the following graph:

![Graph](image)

Figure 1:

2. For example, take a bond that pays \$1 in a year, and \$1 in two years. Take a spot rate curve that slopes upwards dramatically, so that \( r(1) = 1\% \) and \( r(2) = 10\% \). Then \( PV = 1/1.01 + 1/1.1^2 = 1.8165 \). The yield is given by the equation

\[
1.8165 = 1/(1 + y/2) + 1/(1 + y/2)^2,
\]

so we obtain approximately \( y = 6.66\% \). If we consider \( \delta = 0.5 \), then for the price sensitivity we have \( \approx 2.4827 \). If we replace \( r \) by the yield \( y \) we obtain \( \approx 2.5328 \).
3. Using the formula \( P = \sum_{n=1}^{2T} \frac{e^{2T}}{(1+y/2)^n} + \frac{1}{(1+y/2)^T} \) we can easily calculate the price. We obtain that \( P_7(4.75\%) = 101.4741 \) and

\[
\]

For 10 year we calculate \( P_{10}(4.9\%) = 110.57 \) and \( DV01 = 0.0833 \). Therefore, the hedge ratio is \( 0.0594/0.0833 \approx 0.7138 \). In order to be DV01 neutral we need to sell 0.7138 10 year bonds for every 7 year bond we buy.

4. Using the same approach as in Problem 3 we obtain:

\[
\begin{align*}
P_5 &= 101.797 & DV01(5) &= D_5 = 0.04538 \\
P_7 &= 101.474 & DV01(7) &= D_7 = 0.05948 \\
P_{10} &= 110.573 & DV01(10) &= D_{10} = 0.08332
\end{align*}
\]

For the convexity we have \( C_5 = 0.2326 \), \( C_7 = 0.4066 \) and \( C_{10} = 0.7015 \). Therefore, we consider the following linear system of equations:

\[
\begin{align*}
(0.08332)x + (0.04538)y &= 0.05948 \\
(110.573)(0.7015)x + (101.797)(0.2326)y &= (101.474)(0.4066)
\end{align*}
\]

We obtain \( x \approx .297 \) and \( y \approx .764 \).