1). DV01 for bond $= -\dfrac{P(y+0.01\%) - P(y-0.01\%)}{2}$

$= -\dfrac{108.0901 - 108.2615}{2}$

$= 0.0857$

DV01 for option $= -\dfrac{P(y+0.01\%) - P(y-0.01\%)}{2}$

$= -\dfrac{8.0866 - 8.2148}{2}$

$= 0.0641$

2). Face amount of bond = $F_{option} \times \dfrac{DV01_{option}}{DV01_{bond}}$

$= 1m \times \dfrac{0.0641}{0.0857}$

$= \$747958$

We should long \$747958 bond to make the portfolio DV01 neutral.

Q2. Monthly payment $X = \dfrac{B_0 \cdot y}{12} / \left(1 - \left(1+\frac{y}{12}\right)^{-12T}\right)$

$= 100{,}000 \times \frac{5\%}{12} / \left(1 - \left(1+\frac{5\%}{12}\right)^{-12\times25}\right)$

$= \$584.59$

Q3.

We have $D_{c=0} = \frac{T}{1+\frac{y}{2}}$ and $C_{c=0} = \frac{T(T+0.5)}{(1+\frac{y}{2})^2}$

Duration of $A = \frac{10}{1+\frac{3\%}{2}} = 9.8522$

Convexity of $A = (10(10.5)/(1+\frac{3\%}{2})^2 = 101.9195$

Duration of $B = 0.8(2/(1+3\%/2)) + 0.2(30/(1+3\%/2))$

$= 7.4877$

Convexity of $B = 0.8(2(2.5)/((1+\frac{3\%}{2})^2) + 0.2(30(30.5)/((1+\frac{3\%}{2})^2)$

$= 181.5137$

$\therefore$ Duration of B is shorter than A.

convexity of B is larger than A.