Assignment 20: BHZ model

$$\mathcal{H}(k_x, k_y) = \begin{pmatrix} \epsilon(k) + \mathcal{M}(k) & Ak_- & 0 & 0 \\ Ak_+ & \epsilon(k) - \mathcal{M}(k) & 0 & 0 \\ 0 & 0 & \epsilon(k) + \mathcal{M}(k) & -Ak_+ \\ 0 & 0 & -Ak_- & \epsilon(k) - \mathcal{M}(k) \end{pmatrix}$$

$$\begin{cases} \epsilon(k) &= C - Dk^2 \\ \mathcal{M}(k) &= M - Bk^2 \\ k_\pm &= k_x \pm ik_y \end{cases}$$

d (Å)	$A(eV)$	$B(eV)$	$C(eV)$	$D(eV)$	$M(eV)$	
58	-3.62	-18.0	-0.0180	-0.594	0.00922	**$d<d_c$**
70	-3.42	-16.9	-0.0263	0.514	-0.00686	**$d>d_c$**

Table 1: Parameters for $Hg_{0.32}Cd_{0.68}Te/HgTe$ quantum wells.

1) Show that 2 of the 4 bands are always degenerate independently of the parameters.

2) Calculate the value of M such that the energy gap *vanishes* at **k**=(0,0).