1. **[True or False]** For parts (a) and (b), $X$ is a random variable with $\mathbb{E}[X] = \mu$ and $\text{Var}(X) = \sigma^2$.

   (a) \[ \mathbb{P}(X \geq 2\mu) \leq \left( \frac{\sigma}{\mu} \right)^2. \]

   (b) Chebyshev’s inequality tells us that $\mathbb{P}(|X - \mu| \geq \alpha) \leq \frac{\sigma^2}{\alpha^2}$. From this we can conclude that $\mathbb{P}(X - \mu \geq \alpha) \leq \frac{1}{2} \cdot \frac{\sigma^2}{\alpha^2}$.

   (c) If we toss $n$ balls into $k \geq 3$ bins, the number of balls that land in the first 3 bins is distributed according to a binomial distribution.

2. **[Short Answer]** Let $Z$ be a random variable which takes values less than 4. We know that $\mathbb{E}[Z] = 2$.

   (a) Provide an upper bound on $\mathbb{P}(Z \leq 0)$.

   (b) What is a requirement on the variance of $Z$ such that we can guarantee $\mathbb{P}(0 < Z < 4) \geq \frac{1}{2}$?

3. **[Long Answer]** Let $X_i$, where $1 \leq i \leq n$, be i.i.d. with mean $\mu$ and variance $\sigma^2$. Let also $A_n = (X_1 + \cdots + X_n)/n$. Using Chebyshev’s inequality, find a 90% confidence interval for $\mu$. 