1. Let $A$, $B$ and $C$ be events. In each of the following, determine whether the statement is True or False, and write T or F accordingly.

(a) ___ If $A$ and $B$ are independent, then $\mathbb{P}(A^c \cap B^c) = \mathbb{P}(A)^c \mathbb{P}(B)^c$.
(b) ___ If $A$ and $B$ are disjoint, then $\mathbb{P}(A \cup B \mid C) = \mathbb{P}(A \mid C) + \mathbb{P}(B \mid C)$.

2. Let $X$ and $Y$ be random variables. In each of the following, determine whether the statement is True or False, and write T or F accordingly.

(a) ___ If $X$ is continuous and $Y$ is discrete, then $\mathbb{E}[X + Y] = \mathbb{E}X + \mathbb{E}Y$.
(b) ___ If $X, Y \geq 0$, then $\mathbb{P}(X + Y > 0) \geq \mathbb{P}(X > 0) + \mathbb{P}(Y > 0)$.
(c) ___ If $X \geq 0$ and $Y \leq 0$, then $\mathbb{E}[X - Y] \geq 0$.
(d) ___ If $\mathbb{E}X = \mathbb{E}Y$, then $\mathbb{P}(X = 0) = \mathbb{P}(Y = 0)$.
(e) ___ If $\text{Cov}(X, Y) > 0$, then $\text{Var}(X + Y) > \text{Var}(X) + \text{Var}(Y)$.
(f) ___ If $X$ and $Y$ are independent and identically distributed, then $\mathbb{P}(X \geq Y) \geq \frac{1}{2}$.
(g) ___ If $X^2$ is not a constant random variable, then $X$ and $X^2$ are not independent.
(h) ___ If $X^2 = Y^2$, then $X$ and $Y$ cannot be independent.
(i) ___ $\mathbb{E}[\mathbb{E}[X \mid Y]] = \mathbb{E}Y$.

3. Let $X_1, X_2, \ldots$ be a sequence of random variables with mean 0 and variance 1. Let $X$ be another random variable. In each of the following, determine whether the statement is True or False, and write T or F accordingly.

(a) ___ If $X$ has mean 0 and variance 1, then $X_n$ converges to $X$ in distribution.
(b) ___ If $X, X_1, X_2, \ldots$ are i.i.d., then $X_n$ converges to $X$ in probability.

4. Let $X_1, X_2, \ldots$ be a sequence of independent and identically distributed (i.i.d.) random variables with mean 0 and variance 1. In each of the following, determine whether the statement is True or False, and write T or F accordingly.

(a) ___ The probability that $X_1 + \cdots + X_n$ is greater than $n$ converges to 0.
(b) ___ The probability that $X_1 + \cdots + X_n$ is greater than $\sqrt{n}$ converges to $c \in (0.1, 0.2)$.

5. In each of the following, select the correct answer.

(a) Let $X_1, X_2, \ldots$ be a sequence of independent and identically distributed (i.i.d.) random variables with mean 0 and variance 5. The probability that $X_1 + \cdots + X_n$ is less than $n^{2/3}$ converges to
   \begin{align*}
   &A. \ 0 \quad B. \ \frac{1}{2} \quad C. \ 1 \quad D. \ \text{None of these}
   \end{align*}