1. Let $G$ be a random graph chosen uniformly from $G_{n,p}$.
   
   (a) Give an upper bound on the probability that $G$ contains a $k$-clique.
   
   (b) Give an exact formula for the probability of a $k$-clique using the inclusion-exclusion principle.

2. Let $G$ be a random graph chosen uniformly from $G_{n,N}$. Using coupon collecting analysis, compute the probability that edges of $G$ form a vertex cover, i.e. touch every vertex in $G$.

3. Compute the expected number of iterations of the Hamiltonian cycle algorithm using epoch analysis as follows. Let $X_i$ be the number of iterations required to extend the path from length $i-1$ to length $i$. Then
   \[ X = \sum_{i=1}^{n} X_i \]
   
   is the time required to produce a Hamiltonian path. Let $Y$ be the number of iterations required to close the loop (find a cycle) after a Hamiltonian path is found. Compute the total expected running time which is $E[X + Y]$. 