1. Each of the 200 ENGG2430 students shows up to class independently with probability 0.9 and asks Poisson(0.05) questions in there. Let S be the number of students in class and Q the total number of questions asked. Find (a) $\mathrm{E}[S]$, (b) $\mathrm{E}[Q|S]$, (c) $\mathrm{E}[Q]$, (d) $\mathrm{Var}[\mathrm{E}[Q|S]]$, (e) $\mathrm{Var}[Q|S]$, (f) $\mathrm{E}[\mathrm{Var}[Q|S]]$, (g) $\mathrm{Var}[Q]$.

2. You flip a coin with unknown probability of heads p. You want to learn the value of p.

   (a) Alice suggests the following estimator $\hat{P}_A$: Keep flipping the coin until you see the first head in the N-th flip. Set $\hat{P}_A = 1/N$.

   (b) Bob suggests another estimator $\hat{P}_B$: Flip the coin 10 times, count the number of heads Y and set $\hat{P}_B = Y/10$.

   What is the expectation of each estimator in terms of p? Which one is better?

In the next two questions, estimate the quantity of your interest using the method of your choice: Markov's inequality, Chebyshev's inequality, or the Central Limit Theorem. Justify why the method is applicable and discuss the quality of the estimate.

3. The following exam statistics are posted on the course website:

section	no. students	average grade	std. dev.
A	30	65	5
B	20	70	10

   what can you say about the number of students whose exam grade was 30 or below?

4. You are collecting donations for a charity. Each donor gives you \$10 with probability half and \$20 with probability half. Assuming donors are independent, estimate the probability that you have collected at least \$1200 after taking in 100 donations.

5. You randomly divide 48 boys and 48 girls into teams of equal size. Show that if you divide them into 12 teams of 8 then there are no same-sex teams with probability at least 90%.