Group Simulation Activity 1

1) Suppose that we have three fare dice and **x** is a discrete random variable which is the possible outcome of each die. So, **x** can take on values in $\{1,2,3,4,5,6\}$. Also suppose that **y** is a discrete random variable which is the sum of these three dice. So, **y** can take on values in $\{3,4,5,\ldots, 18\}$.
   - I Write a MATLAB code to calculate the PMF of **y**. Then, plot the PMF of **x** and **y**.
   - II Write a MATLAB code to calculate the CDF of **x** and **y** and then plot them.
   - III Suppose that we repeat the experiment of rolling the dice for N times. Generate the outcomes for $N = 100$ trials of rolling these three dice in MATLAB and save the observed values in the vectors x_1, x_2 and x_3. Then, save the sum of the three dice in vector y.
   - IV Write a MATLAB code to count the number of times each number is observed in x_1, x_2, and x_3, and save them in vectors H_1, H_2, and H_3, respectively (for example, if $x_1 = 3$ is observed 120 times, then $H_1(3) = 120$). Then plot the vectors H_1, H_2, and H_2 and compare them with the PMF of **x** you calculated in I. Explain what would you have if you divide H_1, H_2, and H_2 by N.
   - V Write a MATLAB code to count the number of times each possible outcome in y is observed and save them in vector H (for example, if $y = 14$ happens 250 times, then $H(14) = 250$). Then plot vector H and compare it with the PMF of **y** you calculated in I. Explain what the result would be if you divide H by N.
   - VI Increase N to 1 million trials and repeat sections III to V. Explain what happens if you increase N.
2) One million trials of three random variables $RV1$, $RV2$, and $RV3$ are given in the MAT files 'RV1.mat', 'RV2.mat', and 'RV3.mat'. They take on discrete values in $\{0,1,2, \ldots,100\}$. Load them to your workspace in MATLAB and save them with the same names.
   - I Write a MATLAB code to estimate the mean and variance of each of the RVs. Avoid using the MATLAB functions for mean and variance calculation. You can only justify your results by them.
   - II For each RV, write a MATLAB code to count the number of times each number $\{0,1,2,\ldots,100\}$ is observed and save them in vectors H_1, H_2 and H_3. Then divide H_1, H_2 and H_3 by the number of trials (1 million) and plot them. What can you say about the distribution of these RVs (are they Rayleigh, exponential, uniform, Gamma or normal)? (Hint: plot the PDF of the above distributions using the definition of their distribution functions and the statistics you measured at section I and then try to fit them to H_1, H_2 and H_3).
   - III For each RV, using the vectors H_1, H_2 and H_3, write a MATLAB code to estimate the probability that that RV takes values between 10 and 40.

Write a short report and explain your understanding of the results of these simulations.