Math3810 - Probability
Section 001 - Fall 2025
Introductory Homework #3

University of Colorado Denver / College of Liberal Arts and Sciences

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Name: **Student Number:**

Instructions

Show all reasoning clearly. All simulation results should be reproducible and clearly labeled. You may use R for all computations.

Problems

1. **Binomial Simulation**
   (a) Simulate 100 Bernoulli trials with $p = 0.3$.
   (b) Compute the empirical mean and variance.
   (c) Compare to theoretical values.
2. **Multiple Experiments**
   (a) Repeat 3 times with 100 trials each.
   (b) Record empirical proportions each time.
   (c) Comment on variability.
3. **Poisson Approximation**
   (a) Simulate 1000 Poisson($\lambda = 2$) observations.
   (b) Plot histogram and overlay theoretical PMF.
   (c) Compute sample mean and variance.
4. **Law of Large Numbers**
   (a) Simulate sums of n i.i.d. Bernoulli($p = 0.5$) for $n = 10, 100, 1000, 10000$.
   (b) Plot the running proportion of successes.
   (c) Comment on convergence to true probability.
5. **Discussion**
   - Explain why empirical frequencies converge as n increases.
   - How does randomness affect small samples?