Applied Stochastic Processes Cheatsheet

1 Probability

1.1 Basic Concepts

- **Probability of an event** $P(A)$
- **Conditional Probability** $P(A|B) = \frac{P(A \cap B)}{P(B)}$
- **Bayes' Theorem** $P(A|B) = \frac{P(B|A)P(A)}{P(B)}$

2 Random Variables

2.1 Probability Density Function (PDF)

- $f_X(x)$ such that $P(a \leq X \leq b) = \int_a^b f_X(x)\,dx$

2.2 Cumulative Distribution Function (CDF)

- $F_X(x) = P(X \leq x) = \int_{-\infty}^{x} f_X(t)\,dt$

2.3 Expected Value

- Discrete: $E[X] = \sum_x x \cdot P(X = x)$
- Continuous: $E[X] = \int_{-\infty}^{\infty} x \cdot f_X(x)\,dx$

2.4 Variance

- $\mathrm{Var}(X) = E[X^2] - (E[X])^2$

3 Sum of Random Variables

- If X and Y are independent: $f_{X+Y}(z) = \int_{-\infty}^{\infty} f_X(x) f_Y(z-x)\,dx$
- Expected Value: $E[X+Y] = E[X] + E[Y]$
- Variance: $\mathrm{Var}(X+Y) = \mathrm{Var}(X) + \mathrm{Var}(Y)$ (if X and Y are independent)

4 Estimations

4.1 Point Estimation

- Sample Mean: $\hat{\mu} = \frac{1}{n} \sum_{i=1}^{n} X_i$
- Sample Variance: $\hat{\sigma}^2 = \frac{1}{n-1} \sum_{i=1}^{n} (X_i - \hat{\mu})^2$

4.2 Confidence Intervals

- For mean (normal distribution): $\hat{\mu} \pm z_{\alpha/2} \frac{\sigma}{\sqrt{n}}$