**Probability and Applied Statistics Formula Sheet**

**Chapter 2:**

**Mean**:

**Standard Deviation**:

**Variance**:

**Gaussian Distribution**:

* : 68% of measurements
* : 95% of measurements
* : 99.7% of measurements

**Definition 2.6**

* **Axiom 1**:
* **Axiom 2**:
* **Axiom 3**: “If form a sequence of pairwise mutually exclusive events in note that if must be true” : (page 30 of textbook)

**Corollaries of the Axioms**

**MN-Rule** – “With ‘m’ elements and ‘n’ elements , it is possible to form pairs containing one element from each group.” (page 41 of textbook)

**Combination**:

**Permutation**:

**Multinomial Coefficients:**

**Conditional Probability**: denotes the probability of A given B, where this must hold true:

* Also,
* In general:

**Independence vs Dependence**

* 2 events, A and B, are **independent** if:
* Otherwise, **dependent**

**Multiplicative Law of Probability**

* If both A and B are independent, then:

**General Additive Rule** (for arbitrary A and B)

* If both A and B are mutually exclusive, then: and
* Extra Formula (page 58 in the textbook):
  + If and are mutually exclusive:
  + If and are mutually exclusive:
  + By Axiom 3: and
    - So,

Theorem 2.7: **Complement Rule**

**Law of Total Probability**:

* Note that when , implying that and must be mutually exclusive.

**Bayes’ Theorem**

* For events A and B in a sample space S, where and :
* If , then :

**Chapter 3:**

**Probability Distribution**:

* Definition 2.12: “A ***random variable*** is a real-valued function for which the domain is a sample space”
* Definition 3.1: “A random variable Y is said to be ***discrete*** if it can assume only a finite or countably infinite number of distinct values”
* Theorem 3.1: “For any discrete probability distribution, the following must be true:”
  + for all y
  + , where the summation is over all values of y with nonzero probability

**Expected Function**:

**Variance Function:**

**Standard Deviation Function**:

**Binomial Distribution:** where and

* Usage: to find the probability of an event that can either succeed or fail, and run that event a certain amount times.
* Also,
* n: the number of identical trials that are carried out
* : the probability of success
* : the probability of failure
* **Expected:**
* **Variance:**

**Geometric Distribution:** , where and

* Usage: to find the probability of the 1st success based on some number of trials.
* Also,
* : the probability of success
* : the probability of failure
* **Expected:**
* **Variance:**
* **Extra Formulas:**
  + A success occurs on or before the trial:
  + A success occurs before the trial:
  + A success occurs on or after the trial:
  + A success occurs after the trial:

**Negative Binomial Distribution:** , where and

* Usage: to find the probability of the success based on some number of trials.
* Also,
* : the probability of success
* : the probability of failure
* : the number of success (such as 3rd success, or 4th success)
* **Expected:** , and
* **Variance:** , and

**Hypergeometric Probability Distribution:** , where and and

* Usage: the probability of obtaining y-number of items when selecting an n-number of items from the population without replacement, while assuming that all selections are equally likely
* : the number of Type 1 items that you want to obtain
* : the total number of Type 1 items
* : the number of Type 2 items being chosen
* : the total number of Type 2 items
* : the total number of both Type 1 and Type 2 items
* : the total number of both Type 1 and Type 2 items that are being selected together
* **Expected:**
* **Variance:**

**Poisson Probability Distribution:** , where and

* Usage: to acquire the probability of the number of occurrences on a per-unit basis (such as per-unit-time, or per-unit-area)
  + It corresponds to where the incidents (also known as “successes”) occur independently in a continuous time at a constant rate
  + Also, all events must be mutually exclusive, independent, discrete, and random
* : the given average value, or average rate
* **Expected And Variance:**

**Tchebysheff’s Theorem:**  or

* Usage: to find the minimum percentage of the distribution that lies within a certain number of standard deviations of the mean.
* = mean, or expected value
* the standard deviation
* = the number of standard deviations from the mean