# Lab 2: Random Variables and Probability Distributions (Chapter 3)

## Objectives

* Familiarize yourself with random variables, PDFs and CDFs
* Determine probabilities from PDFs or CDFs
* Find the mean and variance from a continuous distribution

## Random Variables and Continuous Distributions

Although we generally consider a specific value of a variable (for example, T = 25°C), most variables should actually be considered to be **random variables, which is a “variable whose measured value can change from one replicate of an experiment to another.”** In other words, there is variability or noise in the measurement of the variable.

A random variable can be discrete or finite. A discrete random variable is when there are only finite set of possible values Any number that can be only represented as integers (with no decimals) will be a discrete variable. For example, if you are counting number of defects on a manufacturing line, you can’t have a portion of a defect; you either have one or you do not. Therefore, the number of defects is a discrete random variable. Most variables in real life, however, are **continuous random variables: a variable for which there is an interval of infinite numbers that the variable can be.**

## Probability

**Probability is the “likelihood that the measurement falls within some set of values.”** Note that for discrete variables, you can find the likelihood that an exact measurement occurs; for continuous variables, you must find the probability of a range. Probability follows these properties:

## Density Functions

A probability distribution is the “description of the set of the probabilities associated with the possible values for X”, where X is the random variable we are studying. A probability density function (PDF), usually denoted as a function f(x), is used to analyze the distribution. **A PDF can be used to calculate the probability of X being between a and b as follows**:

The cumulative density function (CDF) simply calculates the probability of the function being up to a certain number, x; in other words, we are calculating the probability of X being between its lower bound (or negative infinity, if unbounded) and a number x. You can sub in any number (within the valid range) for x to determine the probability of X being anything up to x; in other words, the probability of X<x. **A CDF is denoted by F(x) and is calculated as the integral of the PDF**:

## Probability and Density Function Properties

Some properties that may help you solve problems are:

* , meaning the sum of all probabilities within the defined range (or from negative infinity to infinity, if unbounded) equals 1.
* Probability must be between 0 and 1, because probability is considered to be a percentage or proportion.
* , meaning a PDF must always be non-negative.

## Lab 2 Exercises

1. For the PDF:

for

* 1. Find the value of k such that the expression could be a valid PDF.
  2. Graph the PDF.
  3. Solve for the CDF.

1. For the PDF:

for

* 1. Find the value of k such that the expression could be a valid PDF.
  2. Graph the PDF. What does this show you?

1. Suppose that for 1 < y < 5 and f(y)=0 otherwise. What is the probability that:
   1. 1 < y < 2
   2. 2 < y < 5
   3. 0 < y < 1
   4. 0 < y < 2
   5. 1 < y < 5
   6. Determine y such that P(y<Y)=0.691.