LESSON: STOCHASTICITY AND PROBABILITY

SUMMARY:
The teaching of stochasticity and stochastic processes as a probabilistic principle has been constantly disregarded or totally abandoned because it is considered synonymous to probability theories. It is the objective of this lesson to introduce the students into stochastic processes and verify by comparing and contrasting its properties versus probabilistic processes.

ENGINEERING CONNECTION:
With many engineering applications involve functions over time, the deterministic approach to probability and randomness may not be enough to explain and analyze scientific phenomena and engineering trends. The wide range applicability of stochastic principles includes, but not limited to: model network traffic, structural dynamics, earthquake engineering, nanotechnology, water supply planning, designing engineering models, biochemical approximations, biomedical productions, etc.

Grade Level: 12 (11-12) **Lesson #:** 1,2 & 3 of 5
Time Required: 45 minutes for each activity/lesson
Lesson Dependency : Stochasticity, Probability Principles
Keywords: Stochasticity, deterministic probability, random process

Subject Area: Probability and Statistics
AP Statistics

Key concept: http://en.wikipedia.org/wiki/Stochastic_process

LEARNING OBJECTIVES:
After this lesson, students should be able to:

1. Compare and contrast: stochastic processes versus random processes.
2. Solve real-world problems involving stochasticity.
3. Implement their own stochastic process by completing the assignment.

INTRODUCTION/MOTIVATION:
Simulations will be the main tool to answer probability and stochasticity questions.

Two periods will be spent on class activities to develop ideas of probabilities and estimates of proportions.

Activity #1: Introduction to Probability

Using playing cards, dice, colored tiles etc., students will verify and simulate the Probability Distributions and Sampling Distributions.

Activity #2: Introduction with simulation

Happy Birthday! ***How likely is it that two people in your class have the same birthday?*** There are a number of ways to approach this problem. The most common is to take a survey and see if it happens that two birthdays fall on the same day. But if it happens in the surveyed class, will it occur in another class with different students?

How likely for it to happen in another class will be the stepping-stone for the discussion on probability principles. An extension would be to introduce stochasticity.

LESSON BACKGROUND AND CONCEPT:

THE PROBABILITY DISTRIBUTIONS (covered by the course)
1. The Bernoulli distribution, which takes value 1 with probability p and value 0 with probability $q = 1 - p$.
2. The binomial distribution describes the number of successes in a series of independent Yes/No experiments.
3. The beta-binomial distribution describes the number of successes in a series of independent Yes/No experiments with heterogeneity in the success probability.
4. The geometric distribution, a discrete distribution which describes the number of attempts needed to get the first success in a series of independent Yes/No experiments.
5. The negative binomial distribution is a generalization of the geometric distribution to the nth success.
6. The Poisson distribution describes a very large number of individually unlikely events that happen in a certain time interval.

STOCHASTIC PROCESS Examples:
Examples of processes modeled as stochastic time series include stock market and exchange rate fluctuations, signals such as speech, audio and video, medical data such as a patient's EKG, EEG, blood pressure or temperature, and random movement such as Brownian motion or random walks. Examples of random fields include static images, random terrain (landscapes), or composition variations of a heterogeneous material.

ASSESSMENTS:
1. Completed Activity #1 and #2 Worksheets
2. Homework on Probability Distributions
3. Completed Worksheet on Brownian Motion.
4. Completed Checklist: Probability vs. Stochasticity

References:
Papoulis, Athanasios & Pillai, S. Unnikrishna (2001). *Probability, Random Variables and Stochastic Processes*. McGraw-Hill Science/Engineering/Math. ISBN 0-07-281725-9.