**The University of Jordan**
**School of Engineering**
**Department of Computer Engineering**
**Spring Term -- A.Y. 2023-2024**

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| **Course:** | Probability and Random Processes (0907211) -- 3 Credit Hours. |
| **Catalog Data:** | Fundamental Concepts of Probability (i.e., Set Operation, Sample Space, Events and Probabilities, Probability Axioms, Conditional Probability, Independence, and Bayes' Theorem), Discrete Random Variables (i.e., Bernoulli, Geometric, Binomial, and Poisson Random Variable), Continuous Random Variables (i.e., Uniform, Gaussian, and Standard Normal Random Variables), probability density function, probability distribution function, Expectation and Moments of a random variable, Characteristic function, Expectation of random vectors, Central limit theorem, Markov Chains (i.e., Definitions and properties, Discrete time Markov chains, Continuous time Markov chains). |
| **Prerequisites by Course:** | CPE 0301102. |
| **Prerequisites by Topic:** | Students are assumed to have basic general knowledge in Calculus and basic programming skills required to run simulation models in this course. |
| **Textbook:** | Probability, Random Variables, and Random Signal Principles, 4th Edition, Peyton Z.Peebles. JR. |
| **References:** | 1) Introduction to Probability, 2002, Dimitri P.Bertsekas and John N. Tsitsiklis.<br>2) A First Course in Probability, 9th Edition, Sheldon Ross.<br>3) Fundamentals of Applied Probability and Random Processes, 2005, Oliver C.Ibe. |
| **Website:** | MS Teams and e-Learning website. |
| **Schedule & Duration:** | 15 weeks: 45 lectures, 50 minutes each / 30 lectures, 75 minutes each. |
| **Minimum Student Material:** | Text book, class handouts, instructor keynotes, calculator, access to a personal computer to run simulation models and |

a connection to the Internet.

**Minimum College Facilities:**

E-Learning platform, classroom with whiteboard and projection display facilities, library and computational facilities.

**Course Objectives:**

The aim of the course **is fourfold**:

1) To teach you the fundamentals of probability theory (probabilistic models, discrete and continuous random variables, multiple random variables, etc).

2) To develop your ability to apply probability theory to real-life problems, especially in the field of computer engineering.

3) To teach you some advanced topics (transforms, sums of random variables, random processes, etc).

4) To introduce you to simulation models.

**Course Outcomes (ILOs):**

The **outcomes** of the course are:

1) To understand the fundamentals of probability theory.

2) To understand the applications of probability theory in computer engineering.

3) To be able to develop simple simulation models and compare them to analytical models.

**Course Topics:**

**1) Basic Probability Concepts:**

* Sample Space and Events.

* Definitions of Probability: Axiomatic Definition, Relative-Frequency Definition, Classical Definition.

* Elementary Set Theory: Set Operations, Number of Subsets of a Set, Venn Diagram, Set Identities, Duality Principle.

* Properties of Probability.

* Conditional Probability: Total Probability and the Bayes' Theorem, Tree Diagram.

* Independent Events.

* Combined Experiments.

* Reliability Applications.

**2) Random Variables:**

* Definition of a Random Variable.

* Events Defined by Random Variables.

* Distribution Functions.

* Discrete Random Variables: obtaining PMF from CDF.

* Continuous Random Variables.

* Mixed Random Variables.

**3) Moments of Random Variable:**

* Expectation.

* Expectation of Nonnegative Random Variables.

* Moments of Random Variables and the Variance.

* The Chebyshev Inequality.

* The Markov Inequality.

**4) Special Probability Distributions:**

* Discrete Distributions: Bernoulli Distribution, Binomial Distribution, Geometric Distribution, ”Memorylessness” property of Geometric Distribution, Negative Binomial Distribution, Poisson Distribution, Poisson approximation of Binomial Distribution.

* Continuous Distributions: Uniform Distribution, Exponential Distribution, ”Memorylessness” property of Exponential Distribution, Relationship between the Exponential and Poisson Distribution, Normal Distribution, Normal Approximation of Binomial Distribution, Error Function, Q-Function, Erlang Distribution.

**4) Multiple Random Variables:**

* Joint CDFs of Bivariate Random Variables: Properties of the Joint CDF.

* Discrete Random Variables.

* Continuous Random Variables.

* Determining Probabilities from a Joint CDF.

* Conditional Distributions: Conditional PMF for Discrete Random Variables, Conditional PDF for Continuous, Conditional Means and Variances, Simple Rule for Independence.

* Covariance and Correlation Coefficient.

**5) Functions of Random Variables:**

* Functions of One Random Variable: Linear Functions, Power Functions.

* Expectations of a Function of One Random Variable: Moments of a Linear Function.

* Sums of Independent Random Variables.

* Laws of Large Numbers.

* The Central Limit Theorem.

**6) Transforms.**

**7) Introduction to Random Processes.**

**8) Introduction to Markov Chains and Queueing Theory and their applications to computer engineering.**

**Computer Usage:** Simulation using Python-3 programming language is required.

**Assessments:** Coursework and Exams.

**Grading policy:**

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| Course Work | 20%. |
| Midterm Exam | 30%. |
| Final Exam | 50%. |

**Instructors:** Dr Talal A. Edwan,
Office hours:
TBA.
Room CE 414.

**Class Time and Location:** TBA.