**King Fahd University of Petroleum and Minerals -** Department of Electrical Engineering

#### **EE-315-Probabilistic Methods in Electrical Engineering – Term 142**

**Course Syllabus (Tentative)**

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| **Week** | **Topics** | **book Sections** | **Learning Outcomes**  *The students are expected to be able to* |
| 1  Jan 25-Jan 29 | **Probability**  Introduction to Probability Theory  Set definitions and set operations  Axioms of probability | 1.1-1.2  1.3 | Appreciate the importance of probability theory and its applications in EE.  Understand set definition and operations and use them in defining probability and its axioms. |
| 2  Feb 1-Feb 5 | Joint and conditional probability  Independent events  Combined experiments | 1.4  1.5  1.6 | Understand the concepts of joint probability, conditional probability, independence of events, Bays rules, and total probability theorem.  Construct a combined experiment from two or more sub-experiments. |
| 3  Feb 8-Feb12 | Counting principles  Bernoulli trials  **Random Variables**  The random variable (r.v.) concept  Distribution Function | 1.7  2.1  2.2 | Understand the concepts of permutations, combinations and Bernoulli trials.  Understand the concepts of random variables and distribution function and its properties.  Know the conditions for a function to be a valid random variable. |
| 4  Feb 15-Feb 19 | Density Function  Some Important r. v.’s | 2.3  2.4 | Understand the concept of density function and its properties.  Understand Gaussian random variable and its PDF and CDF.  Understand how to use tables to find distribution function values. |
| 5  Feb22-Feb 26 | Some Important r. v.’s  Conditional distribution and density functions | 2.5  2.6 | Know some examples about important random variables and their CDF and PDF.  Understanding conditional distribution and density and their properties.  Define conditioning events. |
| 6  Mar 1-Mar 5 | Expectation  Moments | 3.1  3.2 | Find the expected value of a random variable and a function of random variable.  Find the absolute moment and central moments.  Find the variance and skew and their relation to central moments  Understand Chebychev's and Markove's inequalities. |
| 7  Mar 8-Mar 12 | Functions that Give Moments  Transformations of a r.v. | 3.3  3.4 | Find the characteristic function and moment generating function of a random variable.  Find the moments of a random variable from characteristic function or moment generating function.  Find the pdf of monotonic and non-monotonic transformation of continuous random variable.  Find the pdf of the transformation of discrete random variable. |
| 8  Mar 15-Mar 19 | **Multiple random variables**  Pairs of r.v.’s  Properties of joint distribution and joint density | 4.1  4.2-4.3 | Understand the concept of vector random variable.  Define the distribution and density functions of joint random variables and their properties.  Find the marginal distribution from the joint distribution function and to find the marginal density function from the joint density function. |
| Midterm Vacation (Mar 22-Mar 26) | | | |
| 9  Mar 29-Apr 2 | Conditional distribution and density  Statistical Independence  Distribution and density of a sum of r.v.’s  Central Limit Theorem | 4.4  4.5  4.6  4.7 | Find the conditional distribution and density function with point conditiong as well as interval conditiong.  Understand the concept of statistical independence.  Find the distribution and density of sum of r.v.'s.  Understand central limit theorem. |
| 10  Apr 5-Apr 9 | Expected value of a function of r. v.’s  Joint characteristic functions  Jointly Gaussian r. v.’s | 5.1  5.2  5.3 | Obtain the expected value of functions of multiple r.v.'s.  Obtain the absolute and central moments.  Find the correlation, covariance and Correlation coefficients.  Understand Joint Characteristic functions  Understand jointly Gaussian r.v.'s and their properties. |
| 11  Apr 12-Apr 16 | Transformations of multiple r.v.’s  Linear transformations of Gaussian r.v.’s  Sampling and some limit theorems | 5.4  5.5  5.7 | Derive the density function of transformation of multiple r.v.'s.  Perform a linear transformation of a set of Gaussian r.v.'s.  Find the sample mean and variance.  Understand the weak and strong laws of large numbers |
| 12  Apr 19-**Apr 23** | **Random Processes –Temporal Characteristics**  Concept of a random process  Stationary and independence  Correlation functions and their properties  Gaussian random process | 6.1  6.2  6.3-6.4  6.5 | Understand the concept of random processes.  Know different classes of r.p.'s  Understand the concepts of stationary and independence of r.p.'s.  Find the auto-correlation, auto-covariance, cross-correlation and cross-covariance functions of r.p.'s.  Understand Gaussian r.p. |
| 13  Apr 26-April 30 | Poisson random process  **Random Processes – Spectral Characteristic**  Power Spectral Density and its properties  Relationship between PSD and autocorrelation function | 6.6  7.1  7.2 | Understand Poisson r.p.  Understand the concept of power density spectrum and its properties.  Find RMS bandwidth of a r.p.  Understand the relationship between PSD and autocorrelation function. |
| 14  May 3-May 7 | **Linear systems with random inputs**  Random signal response of linear systems  Spectral characteristics of system response | 8.2-8.3  8-4 | Analyze LTI systems with random input in time and frequency domains.  Evaluate system response and its mean, mean-squared and auto-correlation values.  Evaluate power spectral density of LTI system response. |
| 15  May 10-May 14 | **Review** |  |  |

**HOMEWORKS:**

* Homework is due last class in the assigned week. Homework is due during class time. Selected problems will be graded.
* Homework is to be solved completely by students and submitted on time. Late submissions will not be accepted. Homework solutions will be posted on Blackboard.
* The following are problem sets of the homework and their due dates. ***Additional homework may be assigned during the semester.***

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| **HW # 1** | 1.1-5, 1.2-3, 1.3-7, 1.3-11, 1.4-5, 1.4-11, 15-6, 1.7-1 | **Due Date: Week 3;** |
| **HW # 2** | 2.1-1, 2.1-7, 2.1-11, 2.2-5, 2.3-2, 2.3-15, 2.4-1, 2.4-6, 2.4-14, | **Due Date: Week 5;** |
| **HW # 3** | 2.5-3, 2.6-3, 3.1-11, 3.1-15, 3.2.-23, 3.2-24, 3.4-2, 3.4-10, | **Due Date: Week 7;** |
| **HW # 4** | 4.2-8, 4.2-11, 4.3-8, 4.3-11, | **Due Date: Week 9;** |
| **HW # 5** | 4.4-3, 4.5-7, 4.6-10, 5.1-4, 5.1-12, 5.1-19, 5.1-34, 5.3-4, 5.4-1, | **Due Date: Week 11;** |
| **HW # 6** | 6.3-1, 6.3-2, 6.3-3, 6.3-5, 6.3-8,6.3-23 | **Due Date: Week 12;** |
| **HW # 7** | 7.1-12, 7.1-16, 7.1-22, 7.2-3, 7.2-10, | **Due Date: Week 14;** |
| **HW # 8** | 8.2-18, 8.4-8, 8.4-10, 8.4-11, | **Due Date: Week 15.** |

**Instructor: Dr. Saad Al-Abeedi**

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* **Email:**  [alabeedi@kfupm.edu.sa](mailto:alabeedi@kfupm.edu.sa) **Office Hours:** Sun and Tue from 11:00 to 12:00 PM.

**Course Description:**

EE 315 an undergraduate course in the Electrical Engineering program. It covers the basic principles of probability, random variables and random processes.

**Course objectives:**

The course aims to provide the students with fundamental concepts of

1. Probability Theory. 2. Single and Multiple Random Variables (Discrete and Continuous).

3. Expectations and Moments. 4. Random Processes and their temporal as well as spectral characteristics.

5. Linear systems with random inputs.

**PREREQUISITE: Signals and Systems (EE 207)**

**TEXT BOOK:**

Peebles, P. Z. “*Probability, Random Variables, and Random Signal Principles*”, McGraw-Hill, 4th Edition, 2001.

**REFERENCES:**

Leon-Garcia, A. “*Probability and Random Processes for EE*”, Addison Wesley, 2nd Edition, 1994.

Ross, S. . “A First Course in *Probability*”, Prentice Hall, Fifth Edition, 1998.

Helstrom, C.W. “*Probability and Stochastic Processes for Engineers*”, Addison-Wesley, 2nd Edition, 1992.

Walpole, R.E., et al.., “*Probability and Statistics for Engineers and Scientists*”, Prentice Hall, Sixth Edition, 1998.

**Policies:**

1. **Grading Policy:**

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| **Class work 25%** | | **Exams 75%** | | |
| Quizzes | Assignments and Projects | Major 1 | Major 2 | Final |
| **15%** | **10%** | **20%** | **20%** | **35%** |

1. **Exams and Quizzes:**

* All students must attend the scheduled exams and quizzes on time and there will be **no** makeups.
* Major exams and final will be coordinated. Students should make sure that they understand all the material in all selected section from the course textbook.
* You should do the HW by yourself. The quizzes will be related to the HW.
* **Major 1:** Sunday, Week 7, March 8, 2015, 6:30-8:00 PM Coverage up to and including Section 3.1
* **Major 2:** Thursday, Week 12, April 23, 2015, 6:30-8:00 PM Coverage up to and including Section 6.4

1. **Attendance:**

* Students without absence will get a bonus of **5** marks. Each absence will cut **1** point from your bonus.
* Each late arrival will cut **½** a point from your grade. A student who comes late for more than **5 minutes** will be marked as **absent**.
* According to the university regulations, any student that exceeds 20% (9 abs) of the scheduled class meeting without an official excuse will receive a grade of DN in the course.
* All official excuses must be submitted to the instructor no later than one week of the date of the official excuse. A late excuse may not be accepted by the instructor.

1. **Active attendance:**

* You are expected to be an active learner, ask questions and participate in class discussions.
* It is absolutely prohibited to use your phone/tablet during class. Before entering the class, make sure that you switched off (or muted) your device.
* Reading other materials, playing with your device or chatting with others are acts of disrespecting the instructor and may result in harsh consequences.

1. **To successfully pass the course with a nice grade, I expect from you TO:**

* be on time,
* be honest, sincere and hardworking learner,
* NOT cheat or copy others work and solutions (including solution manual),
* be an active learner, ask questions and participate in class discussions,
* bring a notebook (or papers) and a pen; we will usually have exercises during class time,
* **avoid** using your mobile or any other source of distraction in the class.