

### **Course Information**

Course Code	5710222
Course Section	1
Course Title	STATISTICAL METHODS FOR COMPUTER ENGINEERING
Course Credit	3
Course ECTS	5.0
Course Catalog Description	Introduction to probability. Discrete and continuous random variables and their distributions. Simulations of random variables. Descriptive statistics. Statistical inference. Regression. Monte Carlo methods. Stochastic processes. Queuing systems. Prerequisite: MATH 120
Prerequisites	Students must complete one of the following sets to take this course.

#### Set Prerequisites

1	2360120	
Tuesd	ay,08:40 - 10	:30, BMB1
Thurso	day, 10:40 - 11	:30, BMB1
ODTU	-Class	
ODTU	-Class	
	Tuesd Thurso ODTU	1 2360120 Tuesday, 08:40 - 10: Thursday, 10:40 - 11 ODTU-Class ODTU-Class

### Instructor Information

Name/Title	Prof.Dr. TOLGA CAN
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	tcantr@gmail.com
Personal Website	http://www.ceng.metu.edu.tr/~tcan
Office Phone	210 5537
Office Hours	By appointment

## **Course Assistants**

Name/Title	Araş.Gör. ÇAĞLAR SEYLAN
Office Address	
Email	
Office Hours	

Name/Title Araş.Gör. SEZAİ ARTUN ÖZYEĞİN Office Address Email Office Hours

# **Course Objectives**

At the end of this course the students will be able to:

- analyze and interpret large scale data,
- apply probability theory and statistics to handle uncertainty,
- infer facts and relationships from collected data, and
- construct simulations by sampling from arbitrary distributions

The course will provide the students the ability to apply knowledge of mathematics, science, and engineering; therefore supporting the corresponding student outcome.



# **Course Learning Outcomes**

The course supports the following student outcomes defined in ABET General Criterion 3 for engineering programs:

- an ability to apply knowledge of mathematics, science, and engineering
- an ability to design and conduct experiments, as well as to analyze and interpret data
- an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

# Program Outcomes Matrix

Undergraduate

		Leve	l of Con	tribution	
	Program Outcomes	0	1	2	3
1	an ability to apply knowledge of mathematics, science, and engineering				Х
2	an ability to design and conduct experiments, as well as to analyze and interpret data				Х
3	an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health, and safety, manufacturability, and sustainability	х			
4	an ability to function on multidisciplinary teams	Х			
5	an ability to identify, formulate, and solve engineering problems		Х		
6	an understanding of professional and ethical responsibility	Х			
7	an ability to communicate effectively	Х			
8	the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context	Х			
9	a recognition of the need for, and an ability to engage in life-long learning		Х		
10	a knowledge of contemporary issues		Х		
11	an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice				Х
12	an ability to apply design and development principles in the construction of software systems of varying complexity.	Х			
<b>0:</b> No	<b>0:</b> No Contribution <b>1:</b> Little Contribution <b>2:</b> Partial Contribution <b>3:</b> Full Contribution				
Instructional Methods					
Formal lectures (3 hrs per week)					
Tentative Weekly Outline					
Wee	ek Topic	Relevant Re	ading	Assignm	nents



1Probability (Chapter 2) : Events and their probabilities (2.1.1) : Rules of probability (2.2) : Conditional probability (2.2) : Conditional probability and independence (2.4)Chapter 22Discrete Random Variables (Chapter 3) : Distribution of a random variable and a random vector. (3.1 and 3.2) : Expectation and variance. (5.3 - excluding 5.3.7)Chapter 3 (5.1, 3.2, 3.3)3Discrete distributions (3.4) : Expectation and variance. (5.3 - excluding 5.3.7)Chapter 3, section 4 (3.4)4Discrete distribution, Binomial distribution, Negative Binomical Distribution, Geometric distribution, Poisson approximation to Binomial.Chapter 3, section 4 (3.4)5Octrinuous distribution, Chapter 4) : Probability density (4.1) : Entrohability density (4.1) : Central Limit. Theorem. (4.3)Chapter 46Statisticul, Chapter 8) : Population and sample, parameters and statistics (8.1) : Confidence intervols. (9.2) : Orapited escriptive statistics. (8.2)Chapter 9. Sections 9.1.9.2, and 9.37Statisticul inference (Chapter 9) : Confidence intervols. (9.2) : Unknown standard deviation. (9.3)Chapter 9. Sections 9.1.9.2, and 9.38uSubstitical inference continued (Chapter 10) : Confidence intervols. (9.2) : Unknown standard deviation. (11.1)Chapter 10. Chapter 11. Section 11110Regression (Chapter 11) : Least squares estimation (11.1)Chapter 10. Chapter 11. Section 111	Week	Торіс	<b>Relevant Reading</b>	Assignments
1Protes of probability (2.2) • Combinatorics (2.3 - studerr reading) • Conditional probability and independence (2.4)Chapter 22Discrete Random Variables (Chapter 3) • Distribution of a random variable and a random vector. (3.1 and 3.2) • Espectation and variance. (3.3 - excluding 3.5.7)Chapter 3 (3.1, 3.2, 3.3)3Discrete distributions (6.4) • Bernouli distribution, Biomial distribution, Negative Binomical Distribution, Binomial.Chapter 5, section 4 (6.4)4Continuous distribution, Poisson distribution, Poisson approximation to Binomial.Chapter 44• Probability density (4.1) • Families of continuous distributions: Uniform distribution, Normal approximation to Binomial.Chapter 45Week 4 continuedChapter 8) • Control and sample, parameters and statistics (8.1) • Control and sample, parameters (0.2) • Unknown standard deviation (0.3)Chapter		Probability (Chapter 2)		
a       Combinatorics (2, 2)         b       Combinatorics (2, 2)         c       Combinatorics (2, 2)         c       Discrete Random Variables (Chapter 3)         c       Distribution of a random variable and a random vector. (3.1 and 3.2)         c       Distribution of a random variable and a random vector. (3.1 and 3.2)         c       Distribution of a random variable and a random vector. (3.1 and 3.2)         c       Distribution and variance. (3.5 - excluding 3.3.7)         c       Discrete distributions (3.4)         c       Discrete distributions (Instribution, Negative Binomical Distribution, Geometric distributions (Chapter 4)         c       Probability density (4.1)         e       Probability density (4.1)         f       Probability density (4.1)         c       Probability density (4.1)         c       Chapter 4         c       Chapter 4         f       Probability density (4.3)         c       Chapter 8         c       Chapter 8)         c       Chapter 8)         c       Probability density (4.2)         c       Parimeter estimation, Chapter 9)         c       Probability density (4.2)         c       Parimeter estimation (9.1)         c<		• Events and their probabilities (2.1.1)		
Image: Image:	1	• Rules of probability (2.2)	Chapter 2	
Image: Statistical inference (Chapter 9)         Chapter 9, Section 9, Statistical inference (Chapter 9)         Chapter 9, Section 9, Statistical inference continued (Chapter 9)           8         Statistical inference continued (Chapter 10)         Chapter 9, Section 9, Statistical inference continued (Chapter 10)           9         Regression (Chapter 11)         Chapter 1, Section 10, Statistical inference continued (Chapter 10)				
2       • Distribution of a random variable and a random vector. (3.1 and 3.2)       Chapter 3 (3.1, 3.2, 3.3)         3       • Expectation and variance. (3.3 - excluding 3.3.7)       Chapter 3, section 4         3       • Bernoulli distribution, Binomial distribution, Negative Binomical Distribution, Geometric distribution, Chapter 4)       Chapter 3, section 4         4       • Probability density (4.1)       • Families of continuous distributions: Uniform distribution, Normal approximation to Binomial. (4.2)       Chapter 4         5       Week 4 continued       Chapter 8         6       • Statistics (Chapter 8)       Chapter 9         7       • Carapter 9, Sections 9, 1, 9, 2, and 9, 3         8       Statistical inference continued (Chapter 9)       • Orapter 9, Sections 9, 1, 9, 2, and 9, 3         8       Statistical inference continued (Chapter 9)       • Hypothesis testing, Type I and Type II errors, Level alpha tests, P-value. (9, 4)         9       • Chapter 11)       Chapter 10		Conditional probability and independence (2.4)		
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3       Discrete distributions (3.4)       Chapter 3, section 4         3 <ul> <li>Bernoulli distribution, Poisson distribution, Negative Binomical Distribution,</li> <li>Geometric distribution, Poisson distribution, Poisson approximation to</li> <li>Binomiat.</li> </ul> <ul> <li>Continuous distributions (Chapter 4)</li> <li>Probability density (4.1)</li> <li>Families of continuous distribution, Normal distribution, Normal approximation to</li> <li>Binomiat.</li> </ul> <ul> <li>Continuous distribution, Gamma distribution, Normal distribution, Normal approximation to Binomiat. (4.2)</li> <li>Central Limit Theorem. (4.3)</li> </ul> <ul> <li>Chapter 4</li> <li>Chapter 8)</li> <li>Central Limit Theorem. (4.3)</li> <li>Statistics (Chapter 8)</li> <li>Graphical statistics. (8.2)</li> <li>Graphical statistics. (8.3)</li> <li>Chapter 9</li> <li>Confidence intervals. (9.2)</li> <li>Confidence intervals. (9.2)</li> <li>Confidence intervals. (9.2)</li> <li>Unknown standard deviation. (9.3)</li> </ul> <ul> <li>Chapter 9, Sections 9, 1, 9, 2, and 9, 3</li> <li>Statistical inference continued (Chapter 9)</li> <li>Hypothesis testing. Type I and Type II errors. Level alpha tests. P-value. (9.4)</li> <li>Chapter 10, Section 10.1</li> <li>Chapter 11, Section 10.1</li> </ul>	2			
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<ul> <li>Graphical statistics. (8.3)</li> <li>Statistical inference (Chapter 9)         <ul> <li>Parameter estimation. (9.1)</li> <li>Confidence intervals. (9.2)</li> <li>Unknown standard deviation. (9.3)</li> </ul> </li> <li>Statistical inference continued (Chapter 9)         <ul> <li>Hypothesis testing. Type I and Type II errors. Level alpha tests. P-value. (9.4)</li> </ul> </li> <li>Statistical inference continued (Chapter 10)         <ul> <li>Chapter 10 Section 10.1</li> <li>Chapter 11)</li> <li>Chapter 11, Section 10.1</li> </ul> </li> </ul>	6		Chapter 8	
<ul> <li>Parameter estimation. (9.1)</li> <li>Confidence intervals. (9.2)</li> <li>Unknown standard deviation. (9.3)</li> <li>Statistical inference continued (Chapter 9)</li> <li>Hypothesis testing. Type I and Type II errors. Level alpha tests. P-value. (9.4)</li> <li>Statistical inference continued (Chapter 10)</li> <li>Chapter 10 Section 10.1</li> <li>Regression (Chapter 11)</li> <li>Chapter 11, Section 11.1</li> </ul>				
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<ul> <li>Unknown standard deviation. (9.3)</li> <li>Statistical inference continued (Chapter 9)         <ul> <li>Hypothesis testing. Type I and Type II errors. Level alpha tests. P-value. (9.4)</li> <li>Statistical inference continued (Chapter 10)             <ul> <li>Chapter 10 Section 10.1</li> <li>Chapter 10 Section 10.1</li> <li>Chapter 11)</li> <li>Chapter 11, Section 11.1</li> </ul> </li> </ul> </li> </ul>	7			
<ul> <li>Statistical inference continued (Chapter 9)         <ul> <li>Hypothesis testing. Type I and Type II errors. Level alpha tests. P-value. (9.4)</li> </ul> </li> <li>Statistical inference continued (Chapter 10)         <ul> <li>Chapter 9, Section 9.4</li> </ul> </li> <li>Statistical inference continued (Chapter 10)             <ul> <li>Chapter 10 Section 10.1</li> <li>Chapter 11, Section 11.1</li> </ul> </li> </ul>				
<ul> <li>8 Hypothesis testing. Type I and Type II errors. Level alpha tests. P-value. (9.4)</li> <li>9 Statistical inference continued (Chapter 10)         <ul> <li>• Chi-square tests (10.1)</li> <li>Chapter 11)</li> <li>Chapter 11, Section</li> <li>10</li> </ul> </li> </ul>				
<ul> <li>Hypothesis testing. Type I and Type II errors. Level alpha tests. P-value. (9.4)</li> <li>Statistical inference continued (Chapter 10)</li> <li>Chi-square tests (10.1)</li> <li>Regression (Chapter 11)</li> <li>Chapter 11, Section</li> <li>Chapter 11, Section</li> </ul>		Statistical inference continued (Chapter 9)	Chapter 9, Section	
9     • Chi-square tests (10.1)     10.1       Regression (Chapter 11)       10     11.1	8	• Hypothesis testing. Type I and Type II errors. Level alpha tests. P-value. (9.4)	9.4	
9     • Chi-square tests (10.1)     10.1       Regression (Chapter 11)       10     11.1		Statistical inference continued (Chapter 10)	Chapter 10 Section	
Regression (Chapter 11) Chapter 11, Section	9	• Chi-square tests (10.1)		
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Least squares estimation. (11.1)	10	Regression (Chapter 11)		
		• Least squares estimation. (11.1)	11.1	



Week	Торіс	Relevant Reading	Assignments
11	<ul> <li>Simulations and Monte Carlo methods (Chapter 5)</li> <li>Simulation of random variables (5.2)</li> <li>Monte Carlo methods (5.3.1 and 5.3.2)</li> </ul>	Chapter 5	
12	<ul><li>Stochastic processes (Chapter 6)</li><li>Markov processes and Markov chains. (6.2)</li></ul>	Chapter 6, Section 6.2	
13	<ul> <li>Stochastic processes continued (Chapter 6)</li> <li>Counting processes (6.3)</li> <li>Simulation of stochastic processes (6.4)</li> </ul>	Chapter 6, Sections 6.3 and 6.4	
14	<ul> <li>Queuing systems (Chapter 7)</li> <li>Main components of a queueing system (7.1)</li> <li>The Little's Law (7.2)</li> <li>Bernoulli single-server queueing process (7.3)</li> </ul>	Chapter 7, Sections 7.1, 7.2, 7.3, and 7.4	

• M/M/1 system (7.4)

## Course Textbook(s)

Probability and Statistics for Computer Scientists, Second Edition, Michael Baron, 2013, 978-1439875902

# Course Material(s) and Reading(s)

### Material(s)

No additional physical material is required.

### Reading(s)

Additional readings:

- Introduction to Probability, Statistics, and Random Processes. Hossein Pishro-Nik, 2014, 978-0990637202
- Probability Theory: The Logic of Science, E. T. Jaynes, 2003, 978-0521592710
- Probability and Random Processes, Grimmett, Geoffrey, and David Stirzaker, 2001, 978-0198572220
- Probability and Statistics with Reliability, Queuing, and Computer Science Applications, Kishor S. Trivedi, 2001, 978-0471333417

## Supplementary Readings / Resources / E-Resources

### Resources

Michael Baron's course web site:

http://www.utdallas.edu/~mbaron/3341/Spring13/index.html

## Assessment of Student Learning

#### Assessment

Dates or deadlines

Homeworks (4 in total)

Exams (1 midterm, 1 final exam)



# Course Grading

Deliverable	Grade Points
3-4 Homeworks	15
Midterm exam	40
Final exam	40
Section specific (active participation, quiz etc.)	5
Total	100

## **Course Policies**

### Class Attendance

Make sure that the section you follow is the section to which your are registered. In case of schedule conflicts, petition for section change.

### **Class Participation**

Communication platform (cow, odtuclass, web page, emails etc.) may depend on the section. Please follow your section instructor, and check your metumail (or the address you registered in the metu system) regularly.

### Make up for Exams and Assignments

Students need to submit approved medical reports to take make-up exams (for the midterm or the final exams).

Other

# Information for Students with Disabilities

To obtain disability related academic adjustments and/or auxiliary aids, students with disabilities must contact the course instructor and the ODTÜ Disability Support Office as soon as possible. If you need any accommodation for this course because of your disabling condition, please contact me. For detailed information, please visit the website of Disability Support Office: http://engelsiz.metu.edu.tr/

## Academic Honesty

The METU Honour Code is as follows: "Every member of METU community adopts the following honour code as one of the core principles of academic life and strives to develop an academic environment where continuous adherence to this code is promoted. The members of the METU community are reliable, responsible and honourable people who embrace only the success and recognition they deserve, and act with integrity in their use, evaluation and presentation of facts, data and documents."