



### MA280 Probability (Online)

<b>Instructor Information</b>	Ying Wang Home Institution: East China Normal University Email: ywang@fem.ecnu.edu.cn		
<b>Term</b>	December 13, 2021 - January 7, 2022	<b>Credits</b>	4 units
<b>Course Delivery</b>	The class will be delivered in the format of online. Other than recorded lecture videos, the instructor will arrange 2 hours' real-time interactions with students per week (via Tencent Meeting or WeChat). The workload students are expected to complete to properly pass this course is about 10-15 hours per week.		
<b>Required Texts (with ISBN)</b>	S. Ross, A First Course in Probability, 10th Edition, Pearson ISBN-13: 9780134753119.		
<b>Prerequisite</b>	<b>Calculus</b>		



## Course Overview

Probability and Estimation Theory is a basic course which help you study random phenomena and their statistical regularity. The main contents include: random events and probability, one-dimensional and multi-dimensional random variables, as well as the parameter estimation methods. This course can cultivate students' ability to use mathematical ideas to design algorithms for practical application problems, lay a foundation for subsequent courses that need mathematical knowledge such as probability theory, and also help students engage in algorithms and other related work and research after graduation to reserve mathematical knowledge and practice mathematical thinking.

## Course Goals

By the end of the course, students who have completed this course successfully should be able to: define random variables, identify the discrete, continuous and other version of the distribution functions, calculate conditional probabilities and identify the dependence structure between various random variables, transform and combine random variables, determine moments includes expectation and variances of functions of the random variables, apply the Law of Large numbers and the Centre Limit Theorem etc.

## Assessment Summary

The final grade of the course is based on

Midterm Exam (40%): 2 hours' Written Test

Final Exam (40%): 2 hours' Written Test

Assignments and Participation (20%)



### Grading Policy

Type	Description	Weight	Due	Length/ Required Time
Assignments and Participation	Home Assignment	20%	TBA	
Midterm Exam	Written Test; On-line Submission	40%	Dec. 24	2 hrs
Final Exam	Written Test; On-line Submission	40%	Jan. 7	2 hrs

### Grading Scale

Number grade	Letter grade	GPA
90-100	A	4.0
85-89	A-	3.7
80-84	B+	3.3
75-79	B	3.0
70-74	B-	2.7
67-69	C+	2.3
65-66	C	2.0
62-64	C-	1.7
60-61	D	1.0
≤59	F (Failure)	0



### Class Schedule

Date	Lecture	Readings	Online Teaching Arrangement
Day 1	Ch 1	<ul style="list-style-type: none"> <li>- Combinatorial analysis</li> <li>- Basic principle of counting               <ul style="list-style-type: none"> <li>- Permutations</li> <li>- Combinations</li> </ul> </li> <li>- Multinomial Coefficients</li> <li>- Number of Integer Solutions of Equations</li> </ul>	Approximately 45-60 minutes pre-recorded video lectures
Day 2	Ch 2	<ul style="list-style-type: none"> <li>- Axioms of probability</li> <li>- Sample space and events</li> <li>- Axioms of probability</li> <li>- Some simple propositions</li> <li>- Sample spaces having equally likely outcomes</li> <li>- Probability as a continuous set function</li> <li>- Probability as a measure of belief</li> </ul>	Approximately 45-60 minutes pre-recorded video lectures
Day 3	Ch 3	<ul style="list-style-type: none"> <li>- Conditional probability</li> <li>- Bayes formula</li> </ul>	Approximately 45-60 minutes pre-recorded video lectures
Day 4	Ch 3	<ul style="list-style-type: none"> <li>- Independent events</li> <li>- <math>P(\cdot   F)</math> Probability</li> </ul>	Approximately 45-60 minutes pre-recorded video lectures
Day 5	Ch 4	<ul style="list-style-type: none"> <li>- Random variables (r.v.)               <ul style="list-style-type: none"> <li>- Discrete r.v.s</li> <li>- Expected value</li> </ul> </li> <li>- Expectation of a function of a r.v.               <ul style="list-style-type: none"> <li>- Variance</li> </ul> </li> </ul>	Approximately 45-60 minutes pre-recorded video lectures
Day 6	Ch 4	<ul style="list-style-type: none"> <li>- Binomial and Bernoulli r.v.               <ul style="list-style-type: none"> <li>- Poisson r.v.</li> </ul> </li> <li>- Negative Binomial and Geometric r.v.</li> <li>- Other discrete probability distributions (Hypergeometric)               <ul style="list-style-type: none"> <li>- Expected value of sums of r.v.</li> </ul> </li> <li>- Properties of the cumulative distribution function</li> </ul>	Approximately 45-60 minutes pre-recorded video lectures
Day 7	Ch 5	<ul style="list-style-type: none"> <li>- Continuous r.v.s</li> <li>- Expectation and variance of continuous r.v.s</li> <li>- Expectation and variance of the uniform and normal r.v.</li> </ul>	Approximately 45-60 minutes pre-recorded video lectures



Day 8	<b>Ch 5</b>	<ul style="list-style-type: none"> <li>- Exponential r.v.s</li> <li>- Other continuous distributions (Gamma, Cauchy)               <ul style="list-style-type: none"> <li>- The distribution of a function of a r.v.</li> </ul> </li> </ul>	Approximately 45-60 minutes pre-recorded video lectures
Day 9	<b>Review</b>		
Day 10	<b>Midterm Exam</b>		2 hrs On-line Submission
Day 11	<b>Ch 6</b>	<ul style="list-style-type: none"> <li>- Jointly distributed r.v.s</li> <li>- Joint distribution functions</li> <li>- Independent r.v.s</li> <li>- Sums of independent r.v.s</li> </ul>	Approximately 45-60 minutes pre-recorded video lectures
Day 12	<b>Ch 6</b>	<ul style="list-style-type: none"> <li>- Conditional distributions: discrete case</li> <li>- Conditional distributions: continuous case (conditional densities)               <ul style="list-style-type: none"> <li>- Order statistics</li> </ul> </li> <li>- Joint probability distribution of functions of r.v.s               <ul style="list-style-type: none"> <li>- Exchangeable random variables</li> </ul> </li> </ul>	Approximately 45-60 minutes pre-recorded video lectures
Day 13	<b>Ch 7</b>	<ul style="list-style-type: none"> <li>- Properties of expectation</li> <li>- Expectation of sums of r.v.s</li> <li>- Moments of the number of events that occur               <ul style="list-style-type: none"> <li>- Covariance</li> <li>- Properties of Variance</li> <li>- Variance of sums of r.v.s</li> <li>- Correlations</li> </ul> </li> </ul>	Approximately 45-60 minutes pre-recorded video lectures
Day 14	<b>Ch 7</b>	<ul style="list-style-type: none"> <li>- Conditional expectation</li> <li>- Conditional expectation and prediction</li> <li>- Moment generating functions</li> </ul>	Approximately 45-60 minutes pre-recorded video lectures
Day 15	<b>Ch 7</b>	<ul style="list-style-type: none"> <li>- Additional properties of normal r.v.s</li> <li>- General definition of expectation</li> </ul>	Approximately 45-60 minutes pre-recorded video lectures
Day 16	<b>Ch 8</b>	<ul style="list-style-type: none"> <li>- Chebyshev's inequality</li> <li>- Weak law of large numbers</li> <li>- Central limit theorem (CLT)</li> <li>- Strong law of large numbers</li> </ul>	Approximately 45-60 minutes pre-recorded video lectures
Day 17	<b>Ch 8</b>	<ul style="list-style-type: none"> <li>- Other inequalities &amp; a Poisson limit result</li> <li>- Bounding the error probability when approximating a sum of independent Bernoulli r.v.s by a Poisson r.v.</li> <li>- Lorenz curve</li> </ul>	Approximately 45-60 minutes pre-recorded video lectures



Day 18	Advanced topics for estimation	<ul style="list-style-type: none"><li>- Estimating parameters</li><li>- Interval estimation</li><li>- Properties of estimation</li></ul>	Approximately 45-60 minutes pre-recorded video lectures
Day 19	<b>Review and Wrap-up</b>		
Day 20	<b>Final Exam</b>		2 hrs On-line Submission