MAT 340: Probability
Fall 2016

Instructor: Dr. Laurie Heyer
Chambers 3027
E-mail: laheyer@davidson.edu
Phone: 894-2267 (office)

Course description: Many aspects of our daily lives are intimately concerned with quantifying and understanding random events. This course lays the mathematical foundations of randomness, and builds upon that foundation to solve numerous problems of general interest and practical importance. The course will prepare you to study mathematical statistics (MAT 341) and other areas of probability theory such as stochastic processes, queuing theory, and time series analysis. In addition to describing methods for applying probability theory to solve problems, this course seeks to increase your awareness of probability in everyday life, and give you practice reading and understanding a mathematics textbook on your own.

Text: Probability and Mathematical Statistics by Prasanna Sahoo, University of Louisville. The textbook is available through the Perusall online reader, and is also posted as a PDF file on Moodle.

Learning Outcomes: At the end of the course, students will be able to

- State the mathematical definitions for key terms of probability theory
- Compute probabilities of events using probability theory definitions and theorems
- Determine properties of discrete and continuous random variables using probability theory definitions and theorems
- Recognize which discrete or continuous distribution is used to model a verbally described quantity
- Write a step-by-step explanation and identify mathematical errors in derivations and calculations in supplied texts
- Identify, describe and discuss probability questions in everyday life situations

Prerequisites: The formal prerequisite for this course is multivariable calculus (MAT 140 or MAT 160). MAT 113 (or equivalent high school course) is strongly recommended, as we will use a few facts about infinite series. Previous experience shows that although several students with these minimal requirements have succeeded in this course, a certain level of mathematical maturity, such as might be gained in a course in linear algebra or introduction to proofs (e.g., MAT 220, 230, or 255), is helpful. I recommend against taking this course if MAT 112 and 140 are your only mathematics courses at Davidson. Please speak with me if you are unsure about your preparation for this course.
**Access and accommodation:**

Together, we will strive for your success in meeting the above learning goals. The components of the course, including the modes of assessing your progress toward these goals, require a range of skills and abilities. Every student’s success is important to me. If there are any circumstances that may affect your performance in the class, please let me know as soon as possible so that we can work together to develop strategies that will meet your needs while fulfilling the requirements of the course.

In particular, if you have a documented disability (or believe you may have a disability) and need a reasonable accommodation to participate fully in this class, complete course requirements, or benefit from the Colleges programs and services, please contact the Academic Access and Disability Resources Office (Nance Longworth, nalongworth@davidson.edu) as soon as possible. You are welcome to speak with me as well, so that we can devise a plan that maximizes your chances of success in the course. All such discussions will be fully confidential.

Please look carefully at the course schedule. If any of the assignments conflict with a major religious holiday for your faith, please let me know. I will make every effort to make the necessary accommodations.

If you must miss class for any reason, excused or otherwise, you are responsible for getting notes from a classmate and making up the work you miss. Anticipated absences, e.g., for athletic or family events, should be communicated to me in advance, and any work due those days should be turned in before you leave.

**Attendance:**

Missing class will adversely affect your grade in many ways. In addition, the college attendance policy will be enforced: missing more than 25% of class meetings makes you eligible for a failing grade.

**Course components:**

**Reading assignments.** Reading a mathematics textbook is a skill you will develop in this class. Research shows that you will learn more, and retain the knowledge longer, if you construct your own knowledge. Therefore, I will not lecture and deliver the material that you will understand better if you read it and grapple with it on your own. You will be expected to read the assigned section before class via the Perusall system for collaborative reading and annotation, and you will be graded on your engagement with the text before class. See the handout on Moodle for more details and examples. It is essential that you come to class prepared to discuss the more difficult or confusing aspects of the reading, and work on problems in small groups.
Problem sets. Problem-solving is a critical part of this course. Several problems will be assigned each class day, and you will normally have time to work on assignments in class. Answers to most textbook problems are in the back of the book, and you may use these to check your work. It is up to you whether you meet as a group outside of class to finish assignments. You may get help from anyone you wish, but you must acknowledge all of your sources.

I will randomly select groups to present solutions to most problems at the beginning of the next class. The goal is for each group to present one problem each class period, so that everyone gets a roughly equal number of opportunities to present. You will be graded on both the accuracy and clarity of the presentation, as follows:

- 4 – a clear presentation with no mathematical errors and no help
- 3 – a reasonably clear presentation with few errors and little help
- 2 – a muddled presentation with several errors and/or significant help
- 1 – unprepared to present

If your group does not get to present because of time constraints, you will be graded on your solution as written in class.

Class Participation: During class, we will discuss the reading and work together to fill in missing or confusing details. Typically, you will also have time to start the next assignment in class. You must do all in-class work on the whiteboards in the classroom. I recommend assigning a scribe each day to copy or take pictures of your work and send these notes to everyone in the group. Your class participation grade will be based on your preparation and engagement in these activities, which includes ensuring that your entire group is similarly engaged and following the discussion.

Probability logbook. The logbook is a collaborative online journal used to record and discuss thoughts about probability theory and its applications. You must write at least one post per week, where each week is assumed to end at midnight on Sunday. Each original post should be on the order of 50 words or more. Replies to other posts may be shorter, but to count as a post must have meaningful content. You may discuss how topics covered in this class are connected to other mathematics courses, but most posts should relate to your everyday life. For example, you might pose a question about the probability of things you observe or experience. Grades will be based on the number and quality of posts, with special consideration for original posts that generate meaningful discussions.

Reviews and Final Exam. There will be two take-home, closed-book, limited-time reviews. The first review (distributed on September 23 and due on September 26) will cover Chapters 1-4. The second review (distributed on November 7 and due on November 9) will cover Chapters 5-8 plus indicator random variables. The final exam will be comprehensive and self-scheduled.
Office Hours:
I will have regular drop-in office hours Monday and Wednesday 2:00-3:30 pm, and Tuesday and Thursday 2:30-4:00 pm. You will often find me available in my office at other times of day. Please feel free to drop by anytime my office door is open, or make an appointment for a specific time other than those I have listed. Email is a great way to reach me, day or night.

Grade Computation: Your final course grade will be computed as follows:
- Reading assignments: 10%
- In-class participation: 10%
- Problem presentations: 10%
- Logbook: 10%
- Review I: 20%
- Review II: 20%
- Final Exam: 20%

Honor Code Considerations:
The take-home nature of the reviews in this course warrants particular attention to the Honor Code. On each of these reviews, you will be expected to work entirely on your own, refraining from discussion of the review with anyone, from the time you receive it until the time everyone in the class has turned it in.

Approximate Daily Schedule

<table>
<thead>
<tr>
<th>Date</th>
<th>Reading</th>
<th>Section and Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>22-Aug</td>
<td>1-5</td>
<td>1.1: Introduction</td>
</tr>
<tr>
<td>24-Aug</td>
<td>6-10</td>
<td>1.2: Binomial theorem</td>
</tr>
<tr>
<td>26-Aug</td>
<td>11-23</td>
<td>1.3: The probability measure and sample spaces</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.4: Properties of probability measure</td>
</tr>
<tr>
<td>29-Aug</td>
<td>27-35</td>
<td>2.1: Conditional probability</td>
</tr>
<tr>
<td>31-Aug</td>
<td>35-40</td>
<td>2.2: Bayes’ Theorem</td>
</tr>
<tr>
<td>5-Sep</td>
<td>45-55</td>
<td>3.1: Random variables; 3.2: Distribution functions of discrete RV</td>
</tr>
<tr>
<td>7-Sep</td>
<td>55-61</td>
<td>3.3: PDF and CDF of continuous RV</td>
</tr>
<tr>
<td>9-Sep</td>
<td>61-68</td>
<td>3.4: Percentiles</td>
</tr>
<tr>
<td>12-Sep</td>
<td>74-81</td>
<td>4.1: Moments; 4.2: Expected value</td>
</tr>
<tr>
<td>14-Sep</td>
<td>81-86</td>
<td>4.3: Variance</td>
</tr>
<tr>
<td>16-Sep</td>
<td>91-103</td>
<td>4.5: Moment generating functions</td>
</tr>
<tr>
<td>19-Sep</td>
<td></td>
<td>More on MGF’s</td>
</tr>
<tr>
<td>21-Sep</td>
<td>87-91</td>
<td>4.4: Chebychev’s inequality</td>
</tr>
<tr>
<td>23-Sep</td>
<td>——</td>
<td>Catch up and prepare for Review I</td>
</tr>
<tr>
<td>26-Sep</td>
<td>——</td>
<td>Review I due; casino games</td>
</tr>
<tr>
<td>Date</td>
<td>Pages</td>
<td>Topics</td>
</tr>
<tr>
<td>---------</td>
<td>---------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>28-Sep</td>
<td>108-118</td>
<td>5.1: Bernoulli distribution; 5.2: Binomial distribution</td>
</tr>
<tr>
<td>30-Sep</td>
<td>118-124</td>
<td>5.3: Geometric distribution</td>
</tr>
<tr>
<td>3-Oct</td>
<td>124-129</td>
<td>5.4: Negative binomial distribution</td>
</tr>
<tr>
<td>5-Oct</td>
<td>129-133</td>
<td>5.5: Hypergeometric distribution</td>
</tr>
<tr>
<td>7-Oct</td>
<td>133-137</td>
<td>5.6: Poisson distribution; Midterm logbook evaluation</td>
</tr>
<tr>
<td>10-Oct</td>
<td>FALL BREAK</td>
<td></td>
</tr>
<tr>
<td>12-Oct</td>
<td>142-150</td>
<td>6.1: Uniform distribution</td>
</tr>
<tr>
<td>14-Oct</td>
<td>150-162</td>
<td>6.2: Gamma distribution</td>
</tr>
<tr>
<td>17-Oct</td>
<td>167-174</td>
<td>6.4: Normal distribution</td>
</tr>
<tr>
<td>19-Oct</td>
<td>186-192</td>
<td>7.1: Bivariate discrete random variables</td>
</tr>
<tr>
<td>21-Oct</td>
<td>192-200</td>
<td>7.2: Bivariate discrete random variables</td>
</tr>
<tr>
<td>24-Oct</td>
<td>200-207</td>
<td>7.3: Conditional distribution; 7.4: independent random variables</td>
</tr>
<tr>
<td>26-Oct</td>
<td>214-221</td>
<td>8.1: Covariance</td>
</tr>
<tr>
<td>28-Oct</td>
<td>221-227</td>
<td>8.2: Independence; 8.3: Variance of linear combination</td>
</tr>
<tr>
<td>31-Oct</td>
<td>Indicator random variables</td>
<td></td>
</tr>
<tr>
<td>2-Nov</td>
<td>Indicator random variables</td>
<td></td>
</tr>
<tr>
<td>4-Nov</td>
<td>Indicator random variables</td>
<td></td>
</tr>
<tr>
<td>7-Nov</td>
<td>Prepare for Review II</td>
<td></td>
</tr>
<tr>
<td>9-Nov</td>
<td>Review II due; probability game</td>
<td></td>
</tr>
<tr>
<td>11-Nov</td>
<td>258-263</td>
<td>10.1: Transformations and distribution function method</td>
</tr>
<tr>
<td>14-Nov</td>
<td>263-267</td>
<td>10.2: Transformation method – univariate</td>
</tr>
<tr>
<td>16-Nov</td>
<td>267-278</td>
<td>10.3: Transformation method – bivariate</td>
</tr>
<tr>
<td>18-Nov</td>
<td>278-284</td>
<td>10.4: Convolution method</td>
</tr>
<tr>
<td>21-Nov</td>
<td>285-286</td>
<td>10.5: Moment generating function method</td>
</tr>
<tr>
<td>23-Nov</td>
<td>THANKSGIVING BREAK</td>
<td></td>
</tr>
<tr>
<td>25-Nov</td>
<td>THANKSGIVING BREAK</td>
<td></td>
</tr>
<tr>
<td>28-Nov</td>
<td>353-369</td>
<td>13.1: Distribution of the sample mean and variance</td>
</tr>
<tr>
<td>30-Nov</td>
<td>369-373</td>
<td>13.2: Laws of large numbers</td>
</tr>
<tr>
<td>2-Dec</td>
<td>373-383</td>
<td>13.3: Central Limit Theorem</td>
</tr>
<tr>
<td>5-Dec</td>
<td>Prepare for final exam; Course evaluations</td>
<td></td>
</tr>
<tr>
<td>7-Dec</td>
<td>Prepare for final exam</td>
<td></td>
</tr>
</tbody>
</table>