
Introduction & Syllabus

ECE 341 Random Processes

Lecture #1

Please visit Bison Academy for course syllabus, lecture notes,
recorded lectures, homework sets, and solutions

www.BisonAcademy.com

What is a Random Process?

- A repeatable event
- The outcome changes each time

Not a Random Process

Can I write a program to play poker?

- Either yes or no

Did it rain last April?

- past event: yes or no

Will the Vikings beat the Packers?

- not a repeatable event

Random Process

How long will it take me to write a program similar to playing poker?

- varies: 10 to 1000 minutes

How much will it rain in April?

- varies each year
-

Why is this a required course?

The biggest reason is data analysis

- Anytime you design a circuit or write a program, you want to test it.
- Each time you test your circuit, you'll get different results
- Random Processes gives you tools to analyze such data

Before we get to data analysis, some background on statistics is needed

- First part of the course



Course Content: Combinatorics

- First section
- How can you calculate the odds of an event?

Monte-Carlo Simulations

- Write a program to play a game one time
- The play the game one million times

Enumeration

- List out all possible outcomes
- Count how many times the event happens

Combinatorics

- Calculate the total number of possible outcomes
- Calculate the total number of ways an event can happen
 - example: draw a full-house in poker



Content: Discrete Probability

- Second section

Types of discrete distributions

- Bernoulli Trial
 - Coin toss
- Binomial Distribution
 - N coin tosses
- Uniform Distribution
 - Rolling a die
- Geometric Distribution
 - Roll a die until you get a one
- Pascal Distribution
 - Roll a die until you get N ones

Mathematics for analyzing discrete probabilities

- z-transform
- a.k.a. Moment Generating Functions



Content: Continuous Distributions

- Third topic

Types of continuous distributions

- Uniform
 - Resistor is $1k \pm 5\%$
- Exponential
 - Time until a customer arrives
- Gamma
 - Time until r customers arrive
- Weibull
 - Ad-hoc distribution that fits many distributions
- Normal
 - Bell-shaped curve

Mathematics for analyzing continuous distributions

- LaPlace transform
- a.k.a. Moment Generating Functions



Content: Data Analysis

- Last topic

Student t-Test

- Test of a mean
- What range will the data take with $p=0.9$?

t-Test with Two Populations

- Which population has the higher mean?

Chi-Squared Test

- Is a die fair or loaded?
- Does X have a uniform distribution?

ANOVA

- Do N populations have the same mean?
- Can you lump N populations together?



Course Information

Instructor: Jake Glower

Lecture: In-Person, M-F, noon (Summer)
also live streamed on Zoom
also available on YouTube

Office: ECE 201

Office Hours Zoom: M-F 8am-noon
In-Person: Anytime door is open



Bulletin Description:

Discrete and continuous probability functions. Hypothesis testing. Prereq: Math 166 Calculus II.

Course Objectives:

By the end of the semester, students should:

- Be able to compute probabilities using enumeration and combinatorics
 - Be able to compute probabilities for discrete probability events
 - Be able to compute probabilities for continuous probability events, and
 - Be able to analyze data using various statistical techniques.
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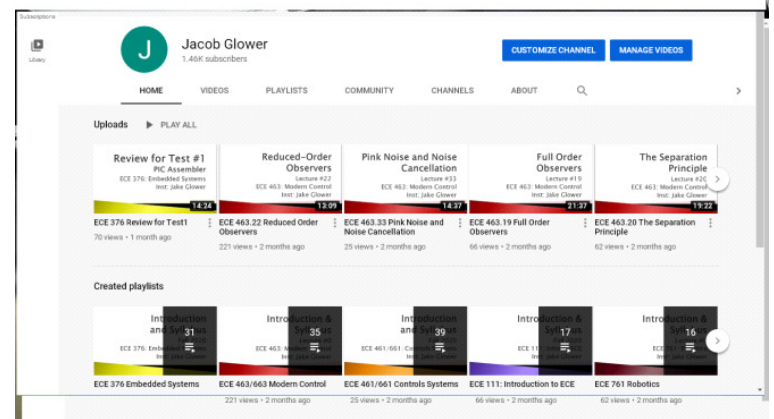
Hy-Flex Model for ECE 341

Students are welcome to take this course however they like:

- In-Person: Students are welcome to attend class at the designated class time and location.
- Live-Stream: Students are also welcome to live-stream the class. A link with how to connect will be sent out at the start of the semester on BlackBoard and to your NDSU email address.
- On-Line: Students are also welcome to take the class on-line and fit lectures into their own schedule.

It doesn't matter which section you signed up for

- You can attend however you like
- There's plenty of room

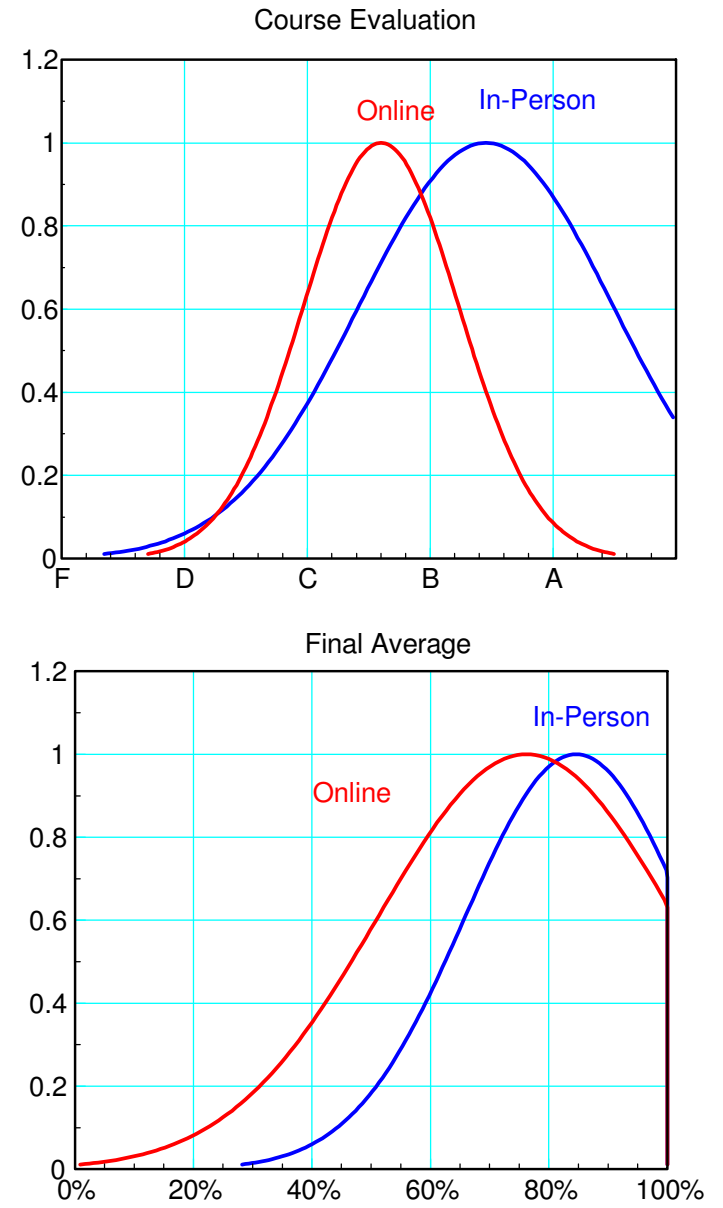


However....

In-Person is better than online

- Course evaluations were a letter grade higher for people who took the course in-person vs. live-stream or online.
- Student's overall average was 7% higher for students who signed up for the in-person version of the class than the online version.

Given a choice, I'd take the class in-person



Required Student Resources:

Matlab (free!)

- Available on all computers in Engineering
- Also available for personal use
- Download instruction under ECE 341

Internet Access

- Syllabus is on Bison Academy
- Lectures & Recorded lectures posted on Bison Academy
- Homework sets posted on Bison Academy



Text Book

- www.BisonAcademy.com (free!)
 - Click on ECE 341 Random Processes
- All lectures posted and available
 - pdf file and YouTube video
 - Available to all students
- Also includes other classes
 - If you want to reference prior material

Other References

- Probability and Stochastic Processes, Yates (\$6 used)
- Probability and Statistics, DeGroot, (\$6 used)
- Principles of Statistics, Bulmer (\$6 used)
- A First Course on Stochastic Processes, Karlin and Taylor (\$11 used)
- Introduction to Statistics: (Univ British Columbia)



BISON ACADEMY

[Advising Info](#)

[ECE Lab Supplies](#)

[ECE 111: Intro to ECE](#)

[ECE 206: Circuits I](#)

[ECE 311: Circuits II](#)

[ECE 320: Electronics I](#)

[ECE 331: Energy Conversion](#)

[ECE 341: Random Processes](#)

[ECE 343: Signals and Systems](#)

[ECE 376: Embedded Systems](#)

[ECE 401: Senior Design I](#)

[ECE 403: Senior Design II](#)

[ECE 405: Senior Design III](#)

[ECE 461: Controls Systems](#)

[ECE 463: Modern Control](#)

[ECE 476: Advanced](#)

[Embedded](#)

[ECE 761: Robotics](#)



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NDSU Online Computer En

NDSU Online Software Eng

NDSU offers degrees in Elec
Engineering, and Software E
students, on-line students, a
web site contains many of th
interested in further inform:

About Bison Academy: This web site contains lecture notes, vide
solutions to compliment courses taught in the Department of Ele
Engineering at North Dakota State University. As a faculty memb
research oriented, land grant university, I, like my colleagues, striv
the best education I can - and this web site is just one of the tool

Homework & Solutions

Posted on Bison Academy

- Due the following class period
- Hardcopy, submit on Blackboard, or email me
- email: Include ECE 341 in the subject line

Homework sets are due by 8am the following day

- That gives me from 8am-noon to grade
- We'll go over the homework the next day
- Solutions will also be posted for online students
 - pdf file & YouTube video

Previous homework sets & solutions are posted on Bison Academy

- Good resource if you get stuck
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ECE 341: Random Processes

Old Homework Sets

Summer 2024	Summer 2023
1: Enumeration Solution #1 (pdf) Solution #1 (YouTube)	1: Enumeration Solution #1 (pdf) Solution #1 (YouTube)
2: Card Games Solution #2 (pdf) Solution #2 (YouTube)	2: Card Games Solution #2 (pdf) Solution #2 (YouTube)
3: Dice Games Solution #3 (pdf) Solution #3 (YouTube)	3: Dice Games Solution #3 (pdf) Solution #3 (YouTube)
4: Binomial & Uniform Solution #4 (pdf) Solution #4 (YouTube)	4: Binomial & Uniform Solution #4 (pdf) Solution #4 (YouTube)
5: Geometric & Pascal Solution #5 (pdf) Solution #5 (YouTube)	5: Geometric & Pascal Solution #5 (pdf) Solution #5 (YouTube)
Test #1 Test #1 Solution (pdf) Test #1 Solution (YouTube)	Test #1 Test #1 Solution (pdf) Test #1 (YouTube)
6: Continuous pdf Solution #6 (pdf) Solution #6 (YouTube)	6: Continuous pdf Solution #6 (pdf) Solution #6 (YouTube)
7: Uniform & Exponential Solution #7 (pdf) Solution #7 (YouTube)	7: Uniform & Exponential Solution #7 (pdf) Solution #7 (YouTube)
8: Gamma & Normal Solution #8 (pdf) Solution #8 (YouTube)	8: Gamma & Normal Solution #8 (pdf) Solution #8 (YouTube)

Submitting Homework Sets

Homework can be submitted as

- Hard copy (in-person),
- Uploaded to BlackBoard, or
- Email to the instructor

For electronic submission, MS Word works well

- Copy and paste Matlab code in to MS Word
- Use snipping tool to copy and paste images into Word
- Document that you're using Matlab and got the correct answer

jpg and pdf files are also OK

- As long as I can open and read your file, I'm OK

ECE 341 - Homework #4
Binomial and Uniform Distributions, Summer 2024

Binomial Distribution
In D8D3, a 5th-level fighter needs to roll a 14 or higher on a 20-sided die to save vs. spell ($p = 7/20$).

$X(x) = \binom{n}{x} p^x (1-p)^{n-x}$

1) Determine the probability of making six saving throws in 10 rolls.
This is a binomial distribution with $p = 0.35$ (7/20).

$p(x) = \binom{n}{x} p^x (1-p)^{n-x}$

$p(x = 6) = \binom{10}{6} (0.35)^6 (0.65)^4$

$p(x = 6) = 0.06891$

2) Determine the probability distribution when rolling this die 10 times.

Option #1: Use a binomial distribution equation for $n = 10$.

Option #2: Use convolution

```
>> p1 = [0.65, 0.35];
>> p2 = conv(p1, p1);
>> p4 = conv(p2, p2);
>> p8 = conv(p4, p4);
>> p10 = conv(p8, p2);
>> n = [10 10];
>> [n, p10]
```

0	0.0107
1.0000	0.1578
2.0000	0.1737
3.0000	0.1522
4.0000	0.2377
5.0000	0.1524
6.0000	0.0689
7.0000	0.0107
8.0000	0.0043
9.0000	0.0005
10.0000	0.0000

30

NOAA has been keeping track of world weather for the past 142 years. 27 of last 30 years have been in the 30 hottest years on record.

3a) What is the probability of any given year being one of the 30 hottest on record (i.e. what is p)?

$p = 30/142 = 0.21127$

3b) What is the probability of 27 of the last 30 years being the hottest on record?

Again, this is a binomial distribution with $p = 30/142$.

$p(x) = \binom{n}{x} p^x (1-p)^{n-x}$

$p(x = 27) = \binom{30}{27} (0.21127)^{27} (0.78873)^3$

$p(x = 27) = 1.174 \cdot 10^{-13}$

There is a chance that nothing is changing and this is just random. The odds against are 8.513e14 : 1 against.

Evaluation Procedures and Grading Criteria

Grades will be the average of the following:

Test #1	Test #2	Test #3	Homework
25%	25%	25%	25%

Grades are rounded to the nearest 1%, with your final grade being

A	B	C	D	F
90% or more	80% - 89%	70% - 79%	60% - 60%	59% or less

Lectures

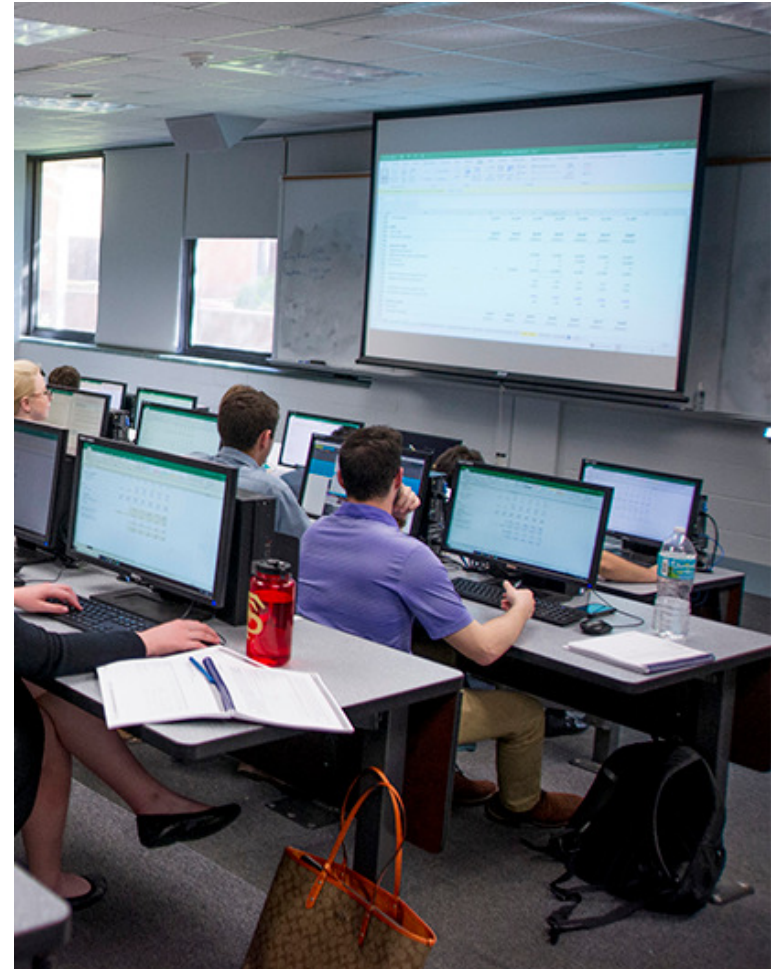
- Monday - Friday
- Noon - 2:15pm
- Also live streamed on Zoom
- Also recorded and posted on YouTube

Note:

- You're welcome to attend however you like
- You're welcome to change how you attend each day
- Makes no difference to me - as long as you can do the homework problems and pass the tests

Office Hours

- 8am-noon on Zoom
 - You can also email me if you have questions
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Legal Stuff:

- Attendance: According to NDSU Policy 333 (www.ndsu.edu/fileadmin/policy/333.pdf), attendance in classes is expected. Students are responsible for the material covered in class and in assignments regardless of their attendance. Note that all lecture notes, homework sets, and solutions are available on-line at www.BisonAcademy.com
 - Students with Special Needs: Any students with disabilities or other special needs, who need special accommodations in this course, are invited to share these concerns or requests with the instructor and contact the Disability Services Office (www.ndsu.edu/disabilityservices) as soon as possible.
 - Academic Honesty: The academic community is operated on the basis of honesty, integrity, and fair play. NDSU Policy 335: Code of Academic Responsibility and Conduct applies to cases in which cheating, plagiarism, or other academic misconduct have occurred in an instructional context. Students found guilty of academic misconduct are subject to penalties, up to and possibly including suspension and/or expulsion. Student academic misconduct records are maintained by the Office of Registration and Records. Informational resources about academic honesty for students and instructional staff members can be found at www.ndsu.edu/academichonesty.
 - Academic Honesty Defined: All written and oral presentations must “respect the intellectual rights of others. Statements lifted verbatim from publications must be cited as quotations. Ideas, summaries or paraphrased material, and other information taken from the literature must be properly referenced” (Guidelines for the Presentation of Disquisitions, NDSU Graduate School).
 - ECE Honor Code: On my honor I will not give nor receive unauthorized assistance in completing assignments and work submitted for review or assessment.
 - Veterans and Student Soldiers: Veterans and student soldiers with special circumstances or who are activated are encouraged to notify the instructor in advance.
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