



## **Math 5040/6810**

Fall Semester 2021

Mon-Wed-Fri 11:50AM - 12:40PM; WEB 1250

**Instructor:** Xiao Shen

**Email:** xiao.shen@utah.edu (preferred method of communication)

**Phone Number:** 781-541-0394

**Office Hours:** Monday from 2:00PM-3:00PM in LCB 202 (or by appointment)

**Office Location:** LCB 202

### **Required Materials**

Textbook: We will mostly follow *Introduction to Stochastic Processes* by Gregory F. Lawler. I will also provide supplementary lecture notes as we go.

### **Pre-requisites**

A probability course at the level of math MATH 5010 is a necessary pre-requisite for the course. Linear algebra is extremely important in this course and comes up frequently. Students should be comfortable with topics like eigenvectors, eigenvalues, and matrix diagonalization.

### **Course Description**

This is a senior/lower-graduate level course in probability theory, so students are expected to be comfortable with proofs. If you are struggling in the class or would like to discuss the course material, please come to my office hours or schedule a time to meet with me early.

There is a tentative schedule below. The current plan is to cover at a basic level:

- Finite state, discrete time Markov chains,
- Countable state, discrete time Markov chains,
- Countable state, continuous time Markov chains,
- Renewal processes.

Along the way, we will also look at some related numerical simulations.

### **Grading Policy**

- Grading will be based on five homework assignments (total of 25%) and three in class midterm exams (25% each). There will be no final exam.
- No make ups for exams, and no late homework. Extenuating circumstances will be handled on a case-by-case basis.
- We will form HW groups in the first week. People in the same group may work together on the homework and turn in one copy of the assignment for their group.

## Tentatively Schedule

Week	Chapters	Topics	Homework/Exam
Week1: 8/23, 8/25, 8/27	1.1, 1.2	Basics of finite Markov chains, transition probabilities	
Week 2: 8/30, 9/1, 9/3	1.2, 1.3	Stationary distributions, periodicity	
Week 3: 9/8, 9/10	1.4, 1.5	Return times, transient states	HW1 due 9/10
Week 4: 9/13, 9/15, 9/17	1.5	Exit times, exit distributions	
Week 5: 9/20, 9/22, 9/24		Examples, and etc.	Exam 1 9/24 HW2 due 9/24
Week 6: 9/27, 9/29, 10/1	2.1, 2.2	Countable state Markov chains, Recurrence and transience	
Week 7: 10/4, 10/6, 10/8	2.2, 2.3	Recurrence and transience, positive and null recurrence	
Week 8: 10/18, 10/20, 10/22	2.4	Branching processes	
Week 9: 10/25, 10/27, 10/29		Examples and etc.	Exam 2 10/29 HW3 due 10/29
Week 10: 11/1, 11/3, 11/5	3.1, 3.2	Continuous time Markov chains, Poisson process	
Week 11: 11/8, 11/10, 11/12	3.2, 3.3	Finite state processes, birth-death processes	
Week 12: 11/15, 11/17, 11/19	3.3, 3.4	Birth-death processes, examples	HW 4 due 11/19
Week 13: 11/22, 11/24	(TBD)	Renewal process	
Week 14: 11/29, 12/1, 12/3	(TBD)	Renewal process limit theorem	
Week 15: 12/6, 12/8		Examples and etc.	Exam 3 12/8 HW5 due 12/8

## University Policies

1. ***The Americans with Disabilities Act.*** The University of Utah seeks to provide equal access to its programs, services, and activities for people with disabilities. If you will need accommodations in this class, reasonable prior notice needs to be given to the Center for Disability Services, 162 Olpin Union Building, (801) 581-5020. CDS will work with you and the instructor to make arrangements for accommodations. All written information in this course can be made available in an alternative format with prior notification to the Center for Disability Services.

- ***If in-class attendance is a necessary component of the course for pedagogical reasons (e.g., laboratories, studios, or artistic training), state it explicitly.***

***Use this standard language:*** “Given the nature of this course, attendance is required and adjustments cannot be granted to allow non-attendance. However, if you need to seek an ADA accommodation to request an exception to this attendance policy due to a disability, please contact the Center for Disability and Access (CDA). CDA will work with us to determine what, if any, ADA accommodations are reasonable and appropriate

2. ***University Safety Statement.*** The University of Utah values the safety of all campus community members. To report suspicious activity or to request a courtesy escort, call campus police at 801-585-COPS (801-585-2677). You will receive important emergency alerts and safety messages regarding campus safety via text message. For more information regarding safety and to view available training resources, including helpful videos, visit [safeu.utah.edu](http://safeu.utah.edu).
3. ***Addressing Sexual Misconduct.*** Title IX makes it clear that violence and harassment based on sex and gender (which includes sexual orientation and gender identity/expression) is a civil rights offense subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories such as race, national origin, color, religion, age, status as a person with a disability, veteran’s status or genetic information. If you or someone you know has been harassed or assaulted, you are encouraged to report it to the Title IX Coordinator in the Office of Equal Opportunity and Affirmative Action, 135 Park Building, 801-581-8365, or the Office of the Dean of Students, 270 Union Building, 801-581-7066. For support and confidential consultation, contact the Center for Student Wellness, 426 SSB, 801-581-7776. To report to the police, contact the Department of Public Safety, 801-585-2677(COPS).
4. ***COVID-19 Fall 2021 Statement***  
*University leadership has urged all faculty, students, and staff to **model the vaccination, testing, and masking behaviors** we want to see in our campus community.*

These include:

- Vaccination
- Masking indoors
- If unvaccinated, getting weekly asymptomatic coronavirus testing

### **Vaccination**

- **Get a COVID-19 vaccination** if you have not already done so. Vaccination is proving highly effective in preventing severe COVID-19 symptoms, hospitalization and death from coronavirus. Vaccination is the single best way to stop this COVID resurgence in its tracks.
- Many in the campus community already have gotten vaccinated:
  - More than 80% of U. employees
  - Over 70% of U. students
- Visit <http://mychart.med.utah.edu/>, <http://alert.utah.edu/covid/vaccine>, or <http://vaccines.gov/> to schedule your vaccination.

### **Masking**

- While masks are no longer required outside of Health Sciences facilities, UTA buses and campus shuttles, **CDC guidelines now call for everyone to wear face masks indoors.**
  - Check the CDC website periodically for masking updates—  
<https://www.cdc.gov/coronavirus/2019-ncov/vaccines/fully-vaccinated-guidance.html>
  - Treat masks like seasonal clothing (i.e. during community surges in COVID transmission, masks are strongly encouraged indoors and in close groups outside).

### **Testing**

- **If you are not yet vaccinated, get weekly asymptomatic coronavirus tests.** This is a helpful way to protect yourself and those around you because asymptomatic individuals can unknowingly spread the coronavirus to others.
  - Asymptomatic testing centers are open and convenient:
    - Online scheduling
    - Saliva test (no nasal swabs)
    - Free to all students returning to campus (required for students in University housing)
    - Results often within 24 hours
    - Visit [alert.utah.edu/covid/testing](http://alert.utah.edu/covid/testing)
- **Remember: Students must self-report if they test positive for COVID-19** via this website: <https://coronavirus.utah.edu/>.

5. **Undocumented Student Support Statement.** Immigration is a complex phenomenon with broad impact—those who are directly affected by it, as well as those who are indirectly affected by their relationships with family members,

friends, and loved ones. If your immigration status presents obstacles to engaging in specific activities or fulfilling specific course criteria, confidential arrangements may be requested from the Dream Center. Arrangements with the Dream Center will not jeopardize your student status, your financial aid, or any other part of your residence. The Dream Center offers a wide range of resources to support undocumented students (with and without DACA) as well as students from mixed-status families. To learn more, please contact the Dream Center at 801.213.3697 or visit [dream.utah.edu](http://dream.utah.edu).

6. **Drop/Withdrawal Policies.** Students may drop a course within the first two weeks of a given semester without any penalties. Students may officially withdraw (W) from a class or all classes after the drop deadline through the midpoint of a course. A “W” grade is recorded on the transcript and appropriate tuition/fees are assessed. The grade “W” is not used in calculating the student’s GPA. For deadlines to withdraw from full-term, first, and second session classes, see the U’s Academic Calendar.
7. Other important information to consider including:
  - a. Student Code: <http://regulations.utah.edu/academics/6-400.php>
  - b. Accommodation Policy (see Section Q):  
<http://regulations.utah.edu/academics/6-100.php>
8. **Student Mental Health Resources**
  - *Rates of burnout, anxiety, depression, isolation, and loneliness have noticeably increased during the pandemic. If you need help, reach out for [campus mental health resources](#), including counseling, trainings and other support.*
  - *Consider participating in a [Mental Health First Aid](#) or other [wellness-themed](#) training provided by our Center for Student Wellness and sharing these opportunities with your peers, teaching assistants and department colleagues*
9. **Student Support.** Your success at the University of Utah is important to all of us here! If you feel like you need extra support in academics, overcoming personal difficulties, or finding community, the U is here for you.

### *Student Support Services (TRIO)*

TRIO federal programs are targeted to serve and assist low-income individuals, first-generation college students, and individuals with disabilities.

Student Support Services (SSS) is a TRIO program for current or incoming undergraduate university students who are seeking their first bachelor's degree and need academic assistance and other services to be successful at the University of Utah.

For more information about what support they provide, a list of ongoing events, and links to other resources, view their website or contact:

**Student Support Services (TRIO)**

801-581-7188

[trio.utah.edu](http://trio.utah.edu)

Room 2075

1901 E. S. Campus Dr.

Salt Lake City, UT 84112

*American Indian Students*

The AIRC works to increase American Indian student visibility and success on campus by advocating for and providing student centered programs and tools to enhance academic success, cultural events to promote personal well-being, and a supportive “home-away-from-home” space for students to grow and develop leadership skills.

For more information about what support they provide, a list of ongoing events, and links to other resources, view their website or contact:

**American Indian Resource Center**

801-581-7019

[diversity.utah.edu/centers/airc](http://diversity.utah.edu/centers/airc)

Fort Douglas Building 622

1925 De Trobriand St.

Salt Lake City, UT 84113

*Black Students*

Using a pan-African lens, the Black Cultural Center seeks to counteract persistent campus-wide and global anti-blackness. The Black Cultural Center works to holistically enrich, educate, and advocate for students, faculty, and staff through Black centered programming, culturally affirming educational initiatives, and retention strategies.

For more information about what support they provide, a list of ongoing events, and links to other resources, view their website or contact:

**Black Cultural Center**

801-213-1441

[diversity.utah.edu/centers/bcc](http://diversity.utah.edu/centers/bcc)

Fort Douglas Building 603

95 Fort Douglas Blvd.

Salt Lake City, UT 84113

### *Students with Children*

Our mission is to support and coordinate information, program development and services that enhance family resources as well as the availability, affordability and quality of child care for University students, faculty and staff.

For more information about what support they provide, a list of ongoing events, and links to other resources, view their website or contact:

#### **Center for Childcare & Family Resources**

801-585-5897

[childcare.utah.edu](http://childcare.utah.edu)

408 Union Building  
200 S. Central Campus Dr.  
Salt Lake City, UT 84112

### *Students with Disabilities*

The Center for Disability Services is dedicated to serving students with disabilities by providing the opportunity for success and equal access at the University of Utah. They also strive to create an inclusive, safe, and respectful environment.

For more information about what support they provide and links to other resources, view their website or contact:

#### **Center for Disability Services**

801-581-5020

[disability.utah.edu](http://disability.utah.edu)

162 Union Building  
200 S. Central Campus Dr.  
Salt Lake City, UT 84112

### *Students of Ethnic Descent*

The Center for Ethnic Student Affairs offers several programs dedicated to the success of students with varied cultural and ethnic backgrounds. Their mission is to create an inclusive, safe campus community that values the experiences of all students.

For more information about what support they provide, a list of ongoing events, and links to other resources, view their website or contact:

#### **Center for Ethnic Student Affairs**

801-581-8151

[diversity.utah.edu/centers/cesa/](http://diversity.utah.edu/centers/cesa/)

235 Union Building

200 S. Central Campus Dr.  
Salt Lake City, UT 84112

### *English as a Second/Additional Language (ESL) Students*

If you are an English language learner, there are several resources on campus available to help you develop your English writing and language skills. Feel free to contact:

#### **Writing Center**

801-587-9122

[writingcenter.utah.edu](http://writingcenter.utah.edu)

2701 Marriott Library

295 S 1500 E

Salt Lake City, UT 84112

#### **English Language Institute**

801-581-4600

[continue.utah.edu/eli](http://continue.utah.edu/eli)

540 Arapeen Dr.

Salt Lake City, UT 84108

### *Undocumented Students*

Immigration is a complex phenomenon with broad impact—those who are directly affected by it, as well as those who are indirectly affected by their relationships with family members, friends, and loved ones. If your immigration status presents obstacles that prevent you from engaging in specific activities or fulfilling specific course criteria, confidential arrangements may be requested from the Dream Center.

**Arrangements with the Dream Center will not jeopardize your student status, your financial aid, or any other part of your residence.** The Dream Center offers a wide range of resources to support undocumented students (with and without DACA) as well as students from mixed-status families.

For more information about what support they provide and links to other resources, view their website or contact:

#### **Dream Center**

801-213-3697

[dream.utah.edu](http://dream.utah.edu)

1120 Annex (Wing B)

1901 E. S. Campus Dr.

Salt Lake City, UT 84112

### *LGBTQ+ Students*

The LGBTQ+ Resource Center acts in accountability with the campus community by identifying the needs of people with a queer range of [a]gender and [a]sexual experiences and responding with university-wide services.

For more information about what support they provide, a list of ongoing events, and links to other resources, view their website or contact:

#### **LGBTQ+ Resource Center**

801-587-7973

[lgbt.utah.edu](http://lgbt.utah.edu) (Links to an external site.)

409 Union Building

200 S. Central Campus Dr.

Salt Lake City, UT 84112

### *Veterans & Military Students*

The mission of the Veterans Support Center is to improve and enhance the individual and academic success of veterans, service members, and their family members who attend the university; to help them receive the benefits they earned; and to serve as a liaison between the student veteran community and the university.

For more information about what support they provide, a list of ongoing events, and links to other resources, view their website or contact:

#### **Veterans Support Center**

801-587-7722

[veteranscenter.utah.edu](http://veteranscenter.utah.edu) (Links to an external site.)

418 Union Building

200 S. Central Campus Dr.

Salt Lake City, UT 84112

### *Women*

The Women's Resource Center (WRC) at the University of Utah serves as the central resource for educational and support services for women. Honoring the complexities of women's identities, the WRC facilitates choices and changes through programs, counseling, and training grounded in a commitment to advance social justice and equality.

For more information about what support they provide, a list of ongoing events, and links to other resources, view their website or contact:

#### **Women's Resource Center**

801-581-8030

[womenscenter.utah.edu](http://womenscenter.utah.edu)

411 Union Building  
200 S. Central Campus Dr.  
Salt Lake City, UT 84112

### *Inclusivity at the U*

The Office for Inclusive Excellence is here to engage, support, and advance an environment fostering the values of respect, diversity, equity, inclusivity, and academic excellence for students in our increasingly global campus community. They also handle reports of bias in the classroom as outlined below:

*Bias or hate incidents consist of speech, conduct, or some other form of expression or action that is motivated wholly or in part by prejudice or bias whose impact discriminates, demeans, embarrasses, assigns stereotypes, harasses, or excludes individuals because of their race, color, ethnicity, national origin, language, sex, size, gender identity or expression, sexual orientation, disability, age, or religion.*

For more information about what support they provide and links to other resources, or to report a bias incident, view their website or contact:

#### **Office for Inclusive Excellence**

801-581-4600

[inclusive-excellence.utah.edu](http://inclusive-excellence.utah.edu) (Links to an external site.)

170 Annex (Wing D)  
1901 E. S. Campus Dr.  
Salt Lake City, UT 84112

### *Other Student Groups at the U*

To learn more about some of the other resource groups available at the U, check out:

[getinvolved.utah.edu/](http://getinvolved.utah.edu/)

[studentsuccess.utah.edu/resources/student-support](http://studentsuccess.utah.edu/resources/student-support)