

University of North Texas
College of Music, Division of Jazz Studies

Introduction to Ableton Live

MUAE 3100-001 (14643), MUJS 5900-706 (4281)

Spring 2022

Tu Thu 9:30a-10:50a, MU263

Course Syllabus

Instructor: Robert Trusko, MA: Robert.Trusko@unt.edu

Office Hours: **Thursdays 12:30-1:50pm**; or by appointment.

Instructor Zoom Meeting Room ID: **273 154 8243**

Course Pre-requisites, Co-requisites, and/or Other Restrictions: None.

Course Description: Introduction through intermediate skill development in MIDI sequencing, recording, editing, mixing and audio mastering using the Ableton Live Digital Audio Workstation (DAW) software for Mac.

Student Learning Outcomes

- Demonstrate basic proficiency as a digital audio engineer, making effective use of the most common tools and keyboard shortcuts in the industry standard software interface.
- Apply a professional workflow and techniques to produce tracks in any genre using software instruments, MIDI, loops and audio.
- Plan and execute a recording session using microphones and direct line input of musical performances on common instruments.
- Learn how to run dynamic live tracks at a performance and live loop.
- Illustrate understanding of basic terms and concepts of sound propagation science, transduction, acoustics, psychoacoustics and signal processing through application to production and post-production techniques.
- Command basic mixing abilities using levels, panning, corrective signal processing (EQ, compression, etc.) and creative signal processing (reverb, delay, distortion, modulation).
- Implement a basic mastering chain on your stereo output for finalizing your tracks to MIDI Sequencing Using Ableton Live commercial specs.
- Compile a shareable portfolio of audio projects, including full-length song arrangements.
- Learn the process for professionally publishing, releasing, and distributing music as an independent artist in the global music industry.

Teaching Philosophy

You will learn by doing in this course. The instructor will present tools and demonstrate their applications, then you will practice applying the same techniques to create your own original music. Each student will produce something unique for every lab assignment and project. You will also learn from each other by in class activities.

Communicating With Your Instructor

Please check Canvas course announcements and your UNT email daily, as these are the means by which the instructors will contact you with important information, updates and reminders.

Please **use Discussions** in our Canvas course for all communication with the instructors and your classmates, unless your communication content needs to be private.

Please **use email** to contact your instructor and assistant instructor with any private questions, concerns, planned absence consultation or office hours appointments:

- Always address emails to Robert.Trusko@unt.edu
- Always use the Subject: "Ableton Live Spring 2022: Your Subject"
- Expect an email response within 24 hours.
- Zoom Number for class or office hours:
- Expect emails you send after 5pm or on weekends to be seen the next work day.
- **Please do not contact me through canvas e-mail, my personal g-mail or any other outlet.**

★ Technical troubleshooting (important): When you run into a problem, try first to solve it yourself through online searches and/or Ableton tech support (<https://www.ableton.com/en/help/>). It is very difficult to diagnose software issues and answer technical questions through email. Please bring technical issues to class where you can get in-person instructor help with anything you cannot resolve otherwise. ★

Format (Canvas-Driven)

Canvas will be the hub for everything in this course. Some lectures will be delivered in person and others will be as step-by-step instructional videos. All will always be accompanied by PDFs. All lab and project assignments will be submitted online via Canvas. All quizzes will be administered online via Canvas.

The lecture material and assignment will all be given *before* our weekly class-meeting. Our class time will be used for follow-up group work, individual work with instructor support, asking and answering questions and/or sharing drafts of your work with the instructor and your classmates.

Typical weekly schedule:

- Friday 8am - New module opens on Canvas with all lecture videos and lab assignment material
- Following Tuesday 9:30am - In class discussion, activities, and workshopping on assignment material, and sometimes continue your individual work on your lab
- Thursday 9:30am- Lab rough draft due at the start of class. Class time used to work out any technical kinks with instructor help, receive instructor and/or classmate feedback on your lab, continue your individual work on your lab.
- Thursday 12:59pm - Lab due to Canvas
- Friday 8am- New module opens on Canvas...

Smartest way to do this class:

1. Look over the new module materials Friday.
2. Watch the videos, complete reading, and get to work on your Lab early (Friday-Tuesday).
3. Give yourself an extra day (Wednesday) for dealing with any unforeseen issues that arise (computer crashing, internet drama, trouble understanding the Lab techniques, life-problems...).
4. Bring your completed Lab to class Thursday to share, get feedback and continue working during class time.
5. Finish and submit your Lab by Thursday night 11:59pm.

Minimum Technical Skills Needed

Using the Canvas learning management system, using email with attachments, zipping and uploading files.

Technical Assistance

UIT Help Desk: <http://www.unt.edu/helpdesk/index.htm>

The University of North Texas provides student technical support in the use of Canvas and supported resources. The student help desk may be reached at:

Email: helpdesk@unt.edu Phone: 940.565-2324

In Person: Sage Hall, Room 130 Hours are:

- Monday-Thursday 8am-midnight
- Friday 8am-8pm
- Saturday 9am-5p
- Sunday 8am-midnight

Canvas technical requirements:

<https://clear.unt.edu/supported-technologies/canvas/requirements>

Ableton Live 11 tech support: <https://www.ableton.com/en/help/>

Materials

LEVEL 1: Required

1. Dropbox (or Google Drive, iCloud, OneDrive or another online storage option) where you can create a folder to upload and share all your projects via download links that you will paste into the assignment submission.

○ **TIP:** Audio session folders are typically hundreds of megabytes to several gigabytes in size. You will not upload these files directly to Canvas, but to cloud storage you can share via links.

- **By submitting assignments this way, you will keep your portfolio in your own online space so you don't lose access to your portfolio after the semester.**
- This also gives you practice sharing Live sets online, which every professional engineer must do a *lot*.
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LEVEL 2: Highly Recommended but Not Required

The following materials are supplied in the Computer Music Lab Media Collaboration Suite (<https://lab.music.unt.edu/media>), in which you can reserve time between classes for 24hrs. As such you are **not required** to purchase any materials for this class.

Purchase of the following materials is *recommended* so that you can work on audio projects at home.

1. **Reference headphones** are required for all audio work. Ear buds and any other headphones you already own are almost assuredly not reference headphones. There are many companies and options, but be sure to choose headphones that *explicitly specify* they have a **flat frequency response for studio reference monitoring**. A popular, affordable option are [Sony MDR 7506](#) reference headphones.

2. **Computer with Ableton Live 11 Suite installed.**

Live works on both PC and Mac, you can find their current minimum requirements [here](#). To give some background about of the versions of Ableton Live [here](#) is a link.

There are two different parts of the name to discuss. The Version (10, 11) and the Edition: Standard vs Suite.

The main differences between editions are a larger library, access to MaxforLive devices (which can save a great deal of time on large productions), and access to a complete set of instruments including all under-the-hood style editing (i.e. discussions of synthesis). The school currently has Live 10 Suite in the Production Suite, Live 11 Standard in the computer lab, and Live 11 Standard in the classroom. Ableton Live is not backwards compatible in both version and edition so please be mindful as you work on projects. If you use a computer with Live 11 Suite you will need to bring it to class or discuss a solution with your professor.

Ableton has been kind enough to offer Professor Trusko and the students of University of North Texas a 90-day-renewable trial for Ableton Live 11 Suite. You can find the download information here. Please be mindful that the 90-day-renewable trial requires you to send an e-mail that must be manually responded to by the Tech Support at Ableton. **The semester is just longer than 90 days so I would recommend that you set an alert in your phone calendar at 80 days to request your renewal.**

Ableton also offers an academic discount for Live 11 which puts the cost at \$269 for Live Standard and Live 11 Suite (for \$449 or 6 monthly payments of \$75). I recommend that students try the software through the semester and purchase once they feel a strong connection to the software. I can attest from my own development that Live 11 Suite is an extremely powerful tool and the under-the-hood style editing for synthesis and MaxforLive devices are well worth the upgrade. If you are hesitant about the price you can always purchase Live 11 Standard and upgrade to Suite for just the cost difference.

3. **MIDI controller.** If you want to input notes and control other Ableton Live 11 parameters not only using your mouse and laptop's keyboard, consider spending \$80-150 on a small USB MIDI controller. E.g. [Akai Pro MPK Mini mk II](#), [Novation Launchkey 25](#), [M-Audio Oxygen 25](#), [Arturia MiniLab MkII](#), [IK Multimedia iRig Keys I/O 25](#), others. Compare the features and pick what suits you best. Some have smaller/larger keys. Some work with iOS as well as Mac OS. Some have bundled software or even built-in USB audio interface capabilities. There are also dedicated Ableton Live Controllers that can control more aspects of the software without any setup or installation in the \$90-\$600. Some of them include the AKAI [APC40 MKII \(And its series\)](#), [Novation Launchpad Series](#), and if one has a larger budget you may want to consider the [Ableton Push 2](#). For a Complete list of Ableton Controllers [click here](#).

LEVEL 3: Recommended but Not Required

You may want to use the following two items to complete some assignments for this class, but both can be accessed in the Computer Music Lab Media Collaboration Suite. Visit <https://lab.music.unt.edu/media> for information and to schedule a time.

5. **Audio recording interface.** This is needed to plug an instrument or microphone into your computer for recording audio into a Ableton Live Session. There are **MANY** available options, ranging from inexpensive to very expensive. A few high quality options I can personally recommend:

- (least expensive but still high quality) [PreSonus AudioBox USB 96](#) or [PreSonus AudioBox 96 Studio USB 2.0 Hardware/Software Recording Kit](#) (includes reference headphones and a microphone as well) or [UAD Volt](#)
- (a little more expensive) [Focusrite Scarlett 2i2](#) or [UAD Volt](#)
- (expensive and high quality) [Apogee Duet](#) is great. Or an [Apollo Twin](#)

6. **Microphone, cable, stand and pop filter.** There are many, MANY microphone options for all budgets. A great mic to start with for studio recording is a [Large-diaphragm condenser microphone](#). I recommend you first set your budget then compare reviews of mics in that budget.

- If you have a mic, you need a [mic cable](#) (be sure to check the length)
- You probably need a mic stand: [full-size](#) / [desktop](#)
- And for recording vocals you'll want a [pop filter](#)

Grading Summary:

40% Lab Exercises (9)
10% Quizzes (4)
20% Attendance
10% Midterm Project
20% Final Project
100% Total

Lab exercises rough drafts will always be due in class Thursday at the start of class. Lab final draft submissions will always be due to Canvas by 11:59 pm on Thursday. ★ **Late submissions are not accepted without advance request of extension** ★. Extension requests are completed on canvas assignment page and **not via email**. To request a deadline extension, you must enter the text "Extension requested. Reason: [your reason]" to the Canvas assignment submission by Thursday 11:59pm. All extension requests made after the deadline will be denied. All requests made by the Thursday 11:59pm deadline will be granted an extra 48-hours until Saturday 11:59pm at the latest to submit your work. Please note that the extension does not apply to the rough draft. All rough drafts will be due on Thursday at the start of class.

Quizzes will be administered via Canvas throughout the semester, covering lecture content, lab techniques and assigned online reading and viewing content. These will be open-note and generally consist of multiple choice and true/false questions.

The **Midterm Project** will be a polished representation of your best MIDI sequencing work for the first half of the semester. You will compose and produce a complete song, at least 3:00 in length with at least 15 *Instrument* and/or *Drum* tracks. You will mix your song according to the specified process and requirements detailed in week 7 and will include a basic mastering chain on your stereo output to bring your song to professional sonic specifications. Your midterm project may include expanded and revised elements from previous lab exercises.

The **Final Project** will be a polished representation of your best MIDI sequencing and audio mixing work for the semester and may include audio tracks and/or video as well. The project will be assigned and completed in 5 parts, each part having specific requirements detailed week by week beginning week 11.

Attendance at all classes is required and necessary to learn the material well. Arrive early because attendance is **taken exactly at the start of class**. Physically being in the room is not enough. To be counted as present you need to participate, fully engaging in all in-class activities. Examples of not participating include: Using your phone; Sleeping; Checking email or doing any non-class work on your computer; Talking to your neighbor or staring at the wall instead of working on in-class exercises; Any disruptive or disrespectful behavior.

Your attendance at each class is scored on a 10-point scale:

10 pts: **Exactly on-time** and present for the class period (i.e. paying attention during instructor demonstrations, doing class work during work time, **having rough draft at the start of class**)

8 pts: *A little late* and/or not fully present (e.g. not not fully paying attention and/or not exclusively doing classwork for this course during work time,)

5 pts: *Very late* and/or hardly present (e.g. being disruptive and/or spending half of the class doing unrelated work, **does not have rough draft**)

0 pts: *Absent* or not present (e.g. being repeatedly disruptive and/or spending most of the class doing unrelated work)

ATTENDANCE, DRAFTS, LATE WORK AND EXTENSION POLICIES:

Absences are only excused for religious holidays, required performances, family emergencies or student illness. You must get documentation or a doctor's note for an absence to be excused. If you need to be absent for a reason that you are not sure fits into these categories, please let me know and we will discuss if it can be excused.

Rough Drafts are due at the beginning of class every Thursday. These must be either downloaded on your laptop or available on a USB-C or 3.0 flash drive. The rough draft must consist of the full project file and an MP3.

Zero Late Work: No late work is accepted without advance request of extension. If you are absent (excused or unexcused), your work is still due on time to Canvas. You are always responsible to check Canvas and complete any lab work or quizzes assigned in your absence. Consult the class schedule (pp. 6-7) for all due dates.

Requesting an Extension

Extension requests are completed on Canvas and **not via email**. To request a deadline extension, you must enter the text "Extension requested. Reason: [your reason] " to the Canvas assignment submission by Tuesday 11:59pm. All extension requests made after the deadline will be denied. All requests made by the Tuesday 11:59pm deadline will be granted an extra 48-hours until Thursday 11:59pm at the latest to submit your work.

IF YOU ARE STRUGGLING IN THIS CLASS:

If you are struggling for any reason please send me an email, talk to me in class or the halls or come by my office *whether or not we have an appointment*. I want to hear what you're experiencing and we will work together to fix it. Depending on your struggle, there might be immediate help from UNT's Office of Disability Accommodation (info and link below) and/or a medical note from a counselor or therapist that will authorize me to accommodate your needs. If your struggle doesn't match either of these, we will work to find another solution.

We will proceed through new material and assignments with a healthy momentum designed to be manageable and helpful. If for any reason you fall off the train and feel unable to catch up, talk to me right away and we'll get you back on board.

Class Schedule:

★ Check Canvas for ALL course materials, assignment details and quizzes ★			
Week	Date	TUES: Lecture	THURS: Rough Draft Due 9:30a, Final at 11:59p
1	1/17	Introductions Tour of Production Suite A Tour of Live Tutorial Creating a song with Loops Lab 1 – Loop Sequence	<i>Lab and project rough drafts will always be due in class Thursday at the start of class. Final draft submissions will always be due to Canvas by 11:59pm. All quizzes will be due by 11:59pm.</i> Lab 1 due Link Jam
2	1/24	<i>Course materials assignments will always open for the week on the previous Friday at 8am.</i> Lab 2- Creating an Arrangement for Live Shows	Lab 2 due Feedback Hot Seat
3	1/31	Lab 3- Sampling and Using the Simpler Device	Lab 3 due Quiz 1
4	2/7	Lab 4- Drums Programming <i>Teacher Deadline: Grades Will Be Posted for Lab 1-3. Individual Meetings will be held during this class.</i>	Lab 4 due Hot Seat
5	2/14	Lab 5 - Bass Sequence Synthesis techniques for sculpting original sounds MIDI automation	Lab 5 & Quiz 2 due Review
6	2/21	Lab 6- Harmony Sequence Digital Audio Recording instruments via mic and line Midterm Assigned	Lab 6 due Review Hot Seat
7	2/28	Midterm Project: 3:00+ complete song with at least 15 tracks, mixed and roughly mastered to specifications and/or live performance of song with tracks.Mixing and Rough Mastering Mixing workflow, signal processing with audio effects, basic mastering chain on the stereo output <i>Teacher Deadline: Grades Will Be Posted for Lab Labs 4–6. Individual Meetings will be held during this class.</i>	Midterm due Review

8	3/7	Music Industry Discussion Lab 7-Industry	Lab 7 due Potential Guest Lecture
9	3/21	Lab 8 Top Writing Collaboration <i>Teacher Deadline: Grades Will Be Posted for Lab Labs 6, Midterm, and 7.</i>	Lab 8 due & Quiz 3 <i>Individual Meetings will be held during this class. 10 minute tracks</i>
10	3/28	Lab 9 – Duo Performance Lab Live Performance Techniques, Clip Automation, Link, Synchronization	Lab 9 due <i>Individual Meetings will be held during this class.</i>
11	4/4	Final Project part 1 Create a full song (to assignment specifications) and/or live performance	Final Project part 1 due Review
12	4/11	Final Project part 2 Add layers, arrange and pre-mix <i>Teacher Deadline: Grades Will Be Posted for Labs 8-9, and Final Project Part 1.</i>	Final Project part 2 due Peer-Pair Reviews
13	4/18	Final Project part 3 Corrective processing: EQ, gates, compressors and limiters Creative processing: reverb, delay, modulation, distortion	Final Project part 3 due Review

14	4/25	Final Project part 4 Mastering chain	Final Project part 4 Due Review
15	5/1	Final Project part 5 Mastering chain	Final Project part 5 Due Listening Party

Topic schedule subject to change **with notice**.

UNT POLICIES AND RESOURCES:

ACADEMIC INTEGRITY

Students caught cheating or plagiarizing will receive a "0" for that particular assignment or exam [or specify alternative sanction, such as course failure]. Additionally, the incident will be reported to the Dean of Students (Office of Academic Integrity), who may impose further penalty. According to the UNT catalog, the term "cheating" includes, but is not limited to: a. use of any unauthorized assistance in taking quizzes, tests, or examinations; b. dependence upon the aid of sources beyond those authorized by the instructor in writing papers, preparing reports, solving problems, or carrying out other assignments; c. the acquisition, without permission, of tests or other academic material belonging to a faculty or staff member of the university; d. dual submission of a paper or project, or resubmission of a paper or project to a different class without express permission from the instructor(s); or e. any other act designed to give a student an unfair advantage. The term "plagiarism" includes, but is not limited to: a. the knowing or negligent use by paraphrase or direct quotation of the published or unpublished work of another person without full and clear acknowledgment; and b. the knowing or negligent unacknowledged use of

materials prepared by another person or agency engaged in the selling of term papers or other academic materials.

See: [Academic Integrity](#)

LINK: https://policy.unt.edu/sites/default/files/06.003.AcadIntegrity.Final_.pdf

STUDENT BEHAVIOR

Student behavior that interferes with an instructor's ability to conduct a class or other students' opportunity to learn is unacceptable and disruptive and will not be tolerated in any instructional forum at UNT. Students engaging in unacceptable behavior will be directed to leave the classroom and the instructor may refer the student to the Dean of Students to consider whether the student's conduct violated the Code of Student Conduct. The university's expectations for student conduct apply to all instructional forums, including university and electronic classrooms, labs, discussion groups, field trips, etc.

See: [Student Code of Conduct](#)

Link: <https://deanofstudents.unt.edu/conduct>

ACCESS TO INFORMATION – EAGLE CONNECT

Your access point for business and academic services at UNT occurs at my.unt.edu. All official communication from the university will be delivered to your Eagle Connect account. For more information, please visit the website that explains Eagle Connect.

See: [Eagle Connect](#)

LINK: eagleconnect.unt.edu/

ODA STATEMENT

The University of North Texas makes reasonable academic accommodation for students with disabilities. Students seeking accommodation must first register with the Office of Disability Access (ODA) to verify their eligibility. If a disability is verified, the ODA will provide you with an accommodation letter. You can now request your Letters of Accommodation ONLINE and ODA will mail your Letters of Accommodation to your instructors. You may wish to begin a private discussion with your professors regarding your specific needs in a course. Note that students must obtain a new letter of accommodation for every semester. For additional information see the Office of Disability Access.

See: [ODA](#)

LINK: disability.unt.edu. (Phone: (940) 565-4323)

UNT Policy Statement on Diversity

UNT values diversity and individuality as part of advancing ideals of human worth, dignity and academic excellence. Diverse viewpoints enrich open discussion, foster the examination of values and exposure of biases, help educate people in rational conflict resolution and responsive leadership, and prepare us for the complexities of a pluralistic society. As such, UNT is committed to maintaining an open, welcoming atmosphere that attracts qualified students, staff, and faculty from all groups to support their success. UNT does not discriminate on the basis of race, color, national origin, religion, sex, sexual orientation, gender identity, gender expression, age, disability, genetic information, or veteran status in its application and admission process, educational programs and activities, employment policies and use of university facilities.

See: [Diversity and Inclusion](#)

Link: <https://idea.unt.edu/diversity-inclusion>

Health and Safety Information

Students can access information about health and safety at: <https://music.unt.edu/student-health-and-wellness>

Registration Information for Students

See: [Registration Information](#)

Link: <https://registrar.unt.edu/students>

Academic Calendar at a Glance, Spring, 2022

See: [Academic Calendar at a Glance](#)

Link: https://registrar.unt.edu/sites/default/files/Spring_2022_Academic_Calendar.pdf

Final Exam Schedule

See: [Spring, 2022 Final Exam Schedule](#)

<https://registrar.unt.edu/exams/final-exam-schedule/spring>

Financial Aid and Satisfactory Academic Progress

Undergraduates

A student must maintain Satisfactory Academic Progress (SAP) to continue to receive financial aid. Students must maintain a minimum 2.0 cumulative GPA in addition to successfully completing a required number of credit hours based on total hours registered. Students cannot exceed attempted credit hours above

150% of their required degree plan. If a student does not maintain the required standards, the student may lose their financial aid eligibility.

Students holding music scholarships must maintain a minimum 2.5 overall cumulative GPA and 3.0 cumulative GPA in music courses.

If at any point you consider dropping this or any other course, please be advised that the decision to do so may have the potential to affect your current and future financial aid eligibility. It is recommended that you to schedule a meeting with an academic advisor in your college or visit the Student Financial Aid and Scholarships office to discuss dropping a course before doing so.

See: [Financial Aid](#)

LINK: <http://financialaid.unt.edu/sap>

Graduates

A student must maintain Satisfactory Academic Progress (SAP) to continue to receive financial aid. Students must maintain a minimum 3.0 cumulative GPA in addition to successfully completing a required number of credit hours based on total registered hours per term. Music scholarships require a 3.5 cumulative GPA. Students cannot exceed maximum timeframes established based on the published length of the graduate program. If a student does not maintain the required standards, the student may lose their financial aid eligibility.

If at any point you consider dropping this or any other course, please be advised that the decision to do so may have the potential to affect your current and future financial aid eligibility. It is recommended you schedule a meeting with an academic advisor in your college, an advisor in UNT-International or visit the Student Financial Aid and Scholarships office to discuss dropping a course.

See: [Financial Aid](#)

LINK: <http://financialaid.unt.edu/sap>

RETENTION OF STUDENT RECORDS

Student records pertaining to this course are maintained in a secure location by the instructor of record. All records such as exams, answer sheets (with keys), and written papers submitted during the duration of the course are kept for at least one calendar year after course completion. Course work completed via the Canvas online system, including grading information and comments, is also stored in a safe electronic environment for one year. You have a right to view your individual record; however, information about your records will not be divulged to other individuals without the proper written consent. You are

encouraged to review the Public Information Policy and the Family Educational Rights and Privacy Act (FERPA) laws and the university's policy in accordance with those mandates.

See: [FERPA](#)

Link: <http://ferpa.unt.edu/>

COUNSELING AND TESTING

UNT's Center for Counseling and Testing has an available counselor whose position includes 16 hours per week of dedicated service to students in the College of Music and the College of Visual Arts and Design. Please visit the Center's website for further information:

See: [Counseling and Testing](#)

Link: <http://studentaffairs.unt.edu/counseling-and-testing-services>.

For more information on mental health issues, please visit:

See: [Mental Health Issues](#)

Link: <https://speakout.unt.edu>.

The counselor for music students is:

Myriam Reynolds

Chestnut Hall, Suite 311

(940) 565-2741

Myriam.reynolds@unt.edu

ADD/DROP POLICY

Please be reminded that dropping classes or failing to complete and pass registered hours may make you ineligible for financial aid. In addition, if you drop below half-time enrollment you may be required to begin paying back your student loans. After the 12th class day, students must first submit a completed "Request to Drop" form to the Registrar's Office. The last day for a student to drop a class in Fall, 2021 is November 12. Information about add/drop may be found at:

See: [Drops and Withdrawals](#)

Link: <https://sfs.unt.edu/class-drop-and-withdrawal-refunds>

(Also see Academic Calendar, listed above)

STUDENT RESOURCES

The University of North Texas has many resources available to students. For a complete list, go to:

See: [Student Resources](#)

Link: https://www.unt.edu/sites/default/files/resource_sheet.pdf