EE5349-001,002 Low Noise Electronics
Spring 2016

Instructor(s): Donald Butler; http://www-ee.uta.edu/eedept/Faculty/Dbutler.htm

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Faculty Profile: https://www.uta.edu/mentis/public/#profile/profile/view/id/957/

Office Hours: MWF2:00-3:00PM

Section Information: EE5349-001 (Live) ,-002 (Web) Low Noise Electronics
Time and Place of Class Meetings: MWF1:00-1:50 TBA

Course Announcements and Material will be posted on the course webpage in Blackboard http://www.uta.edu/blackboard.

Description of Course Content: This course is an introduction to the area of low-noise electronic design. It presents an overview of electronic noise fundamentals, a description of electronic noise models for passive devices and active devices, methods of calculating the electronic noise performance of circuits, and techniques for minimizing electronic noise in circuit design. Low noise design practices will be developed in rf circuits and analog circuits.

Student Learning Outcomes:

1. Introduce graduate students to noise in circuit elements, transistors, diodes, MEMS, and sensors;
2. Provide graduate students a structure for noise modeling in devices, circuits, and systems;
3. Provide graduate students methods for calculating and interpreting noise in devices, circuits and systems.
4. Noise minimization techniques for electronic devices, circuits and systems

Required Textbooks and Other Course Materials:

i. *Low Noise Electronic System Design,* by C.D. Motchenbacher and J.A. Connelly, Wiley Interscience 1993. ISBN 0-471-57742-1 **(Recommended)**
ii. **Instructor notes provided on Blackboard**

References:

i. *Wideband Low Noise Amplifiers Exploiting Thermal Noise Cancellation* by F. Bruccoleri, E.A.M. Klumperink, and B. Nauta, Springer 2005 ISBN 978-1-4020-3187-8.
ii. *Physics of Semiconductor Devices 2nd Ed.* by S.M. Sze, Wiley-Interscience 1981.
iii. *Solid State Electronic Devices 5th Ed.* by B.G. Streetman and S. Banerjee, Prentice-Hall 2000.
iv. *Noise in Solid State Devices and Circuits* by A. van der Ziel, Wiley 1986.
v. *Microwave Transistor Amplifiers* by G. Gonzalez, Prentice-Hall 1984.
vi. *Analog Integrated Circuit Design* by David Johns and Ken Martin, John-Wiley and Sons, 1997 ISBN 0-471-14448-7.

Descriptions of major assignments and examinations:

Midterm Examinations: 1 midterm exam (~March 9)
Final Examination: Final Exam Monday May. 9, 11:00AM-1:30PM
Other Graded Assignments (Homework / Projects / Labs / Research Papers):

Homework roughly every other week, Term Paper/Project due at end of semester, Fri. Apr. 29, 2016.

Attendance: Attendance is required.

Other Requirements: no graduate level prerequisites, no special meetings.

Grading: (tentative)

Homework 10%; Check **Blackboard** for assignments and due dates.
Midterm Exam 25%;
Term Paper/Project 25%
Final Exam 40%

A	>80%
B	70-79.9%
C	60-69.9%
D	50-59.9%
F	<50%

Students are expected to keep track of their performance throughout the semester and seek guidance from available sources (including the instructor) if their performance drops below satisfactory levels. Your grades will be posted on Blackboard to help you monitor your performance in the class.

Expectations for Out-of-Class Study: Beyond the time required to attend each class meeting, students enrolled in this course should expect to spend at least an additional **9** hours per week of their own time in course-related activities, including reading required materials, completing assignments, preparing for exams, etc.

Make-up Exams: Late homework will be penalized at 50% per day late. Homework is due at the beginning of class. Missed exams and quizzes will be given a makeup only for serious illness or emergency and require a doctors certificate or similar written documentation. Students requiring a makeup exam must make an appointment as soon as possible after the scheduled exam date. Any special consideration for travel to conferences or other business/academic travel must be made at the beginning of the semester or as soon as you become aware of the trip.

Grade Grievances: Any appeal of a grade in this course must follow the procedures and deadlines for grade-related grievances as published in the current graduate catalog. http://grad.pci.uta.edu/about/catalog/current/general/regulations/#gradegrievances

Drop Policy: Students may drop or swap (adding and dropping a class concurrently) classes through self-service in MyMav from the beginning of the registration period through the late registration period. After the late registration period, students must see their academic advisor to drop a class or withdraw. Undeclared students must see an advisor in the University Advising Center. Drops can continue through a point two-thirds of the way through the term or session. It is the student's responsibility to officially withdraw if they do not plan to attend after registering. **Students will not be automatically dropped for non-attendance**. Repayment of certain types of financial aid administered through the University may be required as the result of dropping classes or withdrawing. For more information, contact the Office of Financial Aid and Scholarships (http://wweb.uta.edu/aao/fao/).

Americans with Disabilities Act: The University of Texas at Arlington is on record as being committed to both the spirit and letter of all federal equal opportunity legislation, including the *Americans with Disabilities Act (ADA)*. All instructors at UT Arlington are required by law to provide "reasonable accommodations" to students with disabilities, so as not to discriminate on the basis of that disability. Any student requiring an accommodation for this course must provide the instructor with official documentation in the form of a letter certified by the staff in the Office for Students with Disabilities, University Hall 102. Only those students who have officially documented a need for an accommodation

will have their request honored. Information regarding diagnostic criteria and policies for obtaining disability-based academic accommodations can be found at www.uta.edu/disability or by calling the Office for Students with Disabilities at (817) 272-3364.

> As a faculty member, I am required by law to provide **"reasonable accommodation"** to students with disabilities, so as not to discriminate on the basis of that disability. Student responsibility primarily rests with **informing faculty at the beginning of the semester and in providing authorized documentation through designated administrative channels.**
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> If you require an accommodation based upon disability, please meet with me in my office during the first week of classes.

Academic Integrity: Students enrolled in this course are expected to adhere to the UT Arlington Honor Code:

> *I pledge, on my honor, to uphold UT Arlington's tradition of academic integrity, a tradition that values hard work and honest effort in the pursuit of academic excellence.*
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> *I promise that I will submit only work that I personally create or contribute to group collaborations, and I will appropriately reference any work from other sources. I will follow the highest standards of integrity and uphold the spirit of the Honor Code.*

UT Arlington faculty members may employ the Honor Code as they see fit in their courses, including (but not limited to) having students acknowledge the honor code as part of an examination or requiring students to incorporate the honor code into any work submitted. Per UT System *Regents' Rule* 50101, §2.2, suspected violations of university's standards for academic integrity (including the Honor Code) will be referred to the Office of Student Conduct. Violators will be disciplined in accordance with University policy, which may result in the student's suspension or expulsion from the University.

Student Support Services: UT Arlington provides a variety of resources and programs designed to help students develop academic skills, deal with personal situations, and better understand concepts and information related to their courses. Resources include tutoring, major-based learning centers, developmental education, advising and mentoring, personal counseling, and federally funded programs. For individualized referrals, students may visit the reception desk at University College (Ransom Hall), call the Maverick Resource Hotline at 817-272-6107, send a message to resources@uta.edu, or view the information at www.uta.edu/resources.

Electronic Communication: UT Arlington has adopted MavMail as its official means to communicate with students about important deadlines and events, as well as to transact university-related business regarding financial aid, tuition, grades, graduation, etc. All students are assigned a MavMail account and are responsible for checking the inbox regularly. There is no additional charge to students for using this account, which remains active even after graduation. Information about activating and using MavMail is available at http://www.uta.edu/oit/cs/email/mavmail.php.

When sending an email to me, please put the course number as part of the email subject so that I can give it prompt attention.

Student Feedback Survey: At the end of each term, students enrolled in classes categorized as "lecture," "seminar," or "laboratory" shall be directed to complete an online Student Feedback Survey (SFS). Instructions on how to access the SFS for this course will be sent directly to each student through MavMail approximately 10 days before the end of the term. Each student's feedback enters the SFS database anonymously and is aggregated with that of other students enrolled in the course. UT Arlington's effort to solicit, gather, tabulate, and publish student feedback is required by state law; students are strongly urged to participate. For more information, visit http://www.uta.edu/sfs.

Final Review Week: A period of five class days prior to the first day of final examinations in the long sessions shall be designated as Final Review Week. The purpose of this week is to allow students sufficient time to prepare for final examinations. During this week, there shall be no scheduled activities such as required field trips or performances; and no instructor shall assign any themes, research problems or exercises of similar scope that have a completion date during or following this week *unless specified in the class syllabus*. During Final Review Week, an instructor shall not give any examinations constituting 10% or more of the final grade, except makeup tests and laboratory examinations. In addition, no instructor shall give any portion of the final examination during Final Review Week. During this week, classes are held as scheduled. In addition, instructors are not required to limit content to topics that have been previously covered; they may introduce new concepts as appropriate.

Emergency Exit Procedures:

Should we experience an emergency event that requires us to vacate the building, students should exit the room using either the front or rear exit and move toward the nearest exit, which is located to your left, as you leave the classroom. Note, there is an exit down the hall to your right as well. When exiting the building during an emergency, one should never take an elevator but should use the stairwells. Faculty members and instructional staff will assist students in selecting the safest route for evacuation and will make arrangements to assist handicapped individuals.

Inclusion of this verbiage as well as a brief discussion on the matter with your students at the beginning of the term is mandated by UT Arlington Procedure 7-6: Emergency/Fire Evacuation Procedures (https://www.uta.edu/policy/procedure/7-6).

Course Schedule. (Tentative)

Lecture #	Date	Subject
	18-Jan-16	MLK Day - No Classes
1	20-Jan-16	Review Syllabus, Introduction to Electronic Noise in Circuits and Systems
2	22-Jan-16	Probability, Statistics, and Electronic Noise Theory 1
3	25-Jan-16	Johnson Noise and Probability, Statistics, and Electronic Noise Theory 2
4	27-Jan-16	Noise Resistance and Shot Noise
5	29-Jan-16	Flicker (1/f) Noise
6	1-Feb-16	Phasors and Electronic Noise, Complex Correlation
7	3-Feb-16	Band-pass Filters
8	5-Feb-16	Vn-In Noise Model for Amplifiers, Noise Analysis, Input Referred Noise 1
9	8-Feb-16	Vn-In Noise Model for Amplifiers, Noise Analysis, Input Referred Noise 2
10	10-Feb-16	Noise Factor, Noise Figure, and Noise Optimization 1
11	12-Feb-16	Noise Factor, Noise Figure, and Noise Optimization 2
12	15-Feb-16	Signal-to-Noise Ratio vs Noise Factor 1
13	17-Feb-16	Signal-to-Noise Ratio vs Noise Factor 2
14	19-Feb-16	Noise Temperature, Cascaded Amplifiers and Circuits
15	22-Feb-16	Input Referred Noise Minimization
16	24-Feb-16	Model Conversions
17	26-Feb-16	Other Factors in Circuit/System Design 1
18	29-Feb-16	Other Factors in Circuit/System Design 2
19	2-Mar-16	Noise in RF Circuits and Systems 1
20	4-Mar-16	Noise in RF Circuits and Systems 2
21	7-Mar-16	Midterm Review
22	9-Mar-16	Midterm Exam
23	11-Mar-16	Analog and RF Circuit Design Considerations 1
	14-Mar-16	Spring Break - No Class
	16-Mar-16	Spring Break - No Class
	18-Mar-16	Spring Break - No Class
24	21-Mar-16	Analog and RF Circuit Design Considerations 2
25	23-Mar-16	Analog and RF Circuit Design Considerations 3
26	25-Mar-16	Voltage and Current Amplifiers
27	28-Mar-16	Noise Modeling with SPICE
28	30-Mar-16	Noise in Feedback Amplifiers 1
29	1-Apr-16	Noise in Feedback Amplifiers 2
30	4-Apr-16	Electronic Noise Reduction Techniques
31	6-Apr-16	Electronic Noise in Diodes and Diode Sensors
32	8-Apr-16	Electronic Noise in BJTs and BJT Circuits 1
33	11-Apr-16	Electronic Noise in BJTs and BJT Circuits 2
34	13-Apr-16	Electronic Noise in MOSFETs and MOSFET Circuits 1: Low Frequency
35	15-Apr-16	Electronic Noise in MOSFETs and MOSFET Circuits 2: Low Frequency

36	18-Apr-16	Electronic Noise in MOSFETs and MOSFET Circuits 1: High Frequency
37	20-Apr-16	Electronic Noise in MOSFETs and MOSFET Circuits 2: High Frequency
38	22-Apr-16	Electronic Noise in JFETs and JFET Circuits
39	25-Apr-16	ThermoElectromechanical Noise and Microphonics
40	27-Apr-16	Noise in MEMS and MEMS Sensors
41	29-Apr-16	Phase Noise, Term Paper Due
42	2-May-16	Review #1
43	4-May-16	Review #2
44	6-May-16	Review #3: Last Day of Classes
45	9-May-15	Monday, Final Exam 11:00 AM - 1:30PM

As the instructor for this course, I reserve the right to adjust this schedule in any way that serves the educational needs of the students enrolled in this course. –Donald P. Butler

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Database List..... http://www.uta.edu/library/databases/index.php
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