EEE 6321 (Analog IC Design 2)
Syllabus Spring 2023 Rev. 1

			Lecture	Topic	Homework#
Jan	M	9	1	Logistics, Intro to CMOS Analog Design	
Jan	W	11	2	MOS Device Physics, Threshold Voltage	
Jan	F	13	3	FET Models, Small Signal Analysis	
Jan	M	16		**MLK Day: No Class**	
Jan	W	18	4	Design Parameters and Trade-offs	
Jan	F	20	5	CMOS Biasing and Current Mirrors	
Jan	M	23	6	Single-Stage Amplifiers	1: Trade-offs
Jan	W	25	7	Diff-Amps, Active Loads, Op-Amps	1: Trade-offs
Jan	F	27	8	Noise and Feedback basics	1: Trade-offs
Jan	M	30	9	Feedback and Loop Gain in Op-Amps	
Feb	W	1	10	Freq. Response in Op-Amps, Phase Margin	
Feb	F	3	11	CMOS Op-Amp Design	
Feb	M	6	12	Systematic Design of Analog Circuits: Part 1	2: CMOS Op-Amp
Feb	W	8	13	Systematic Design of Analog Circuits: Part 2	2: CMOS Op-Amp
Feb	F	10	14	Design of a StrongArm Latch – 1b ADC	2: CMOS Op-Amp
Feb	M	13	15	Application of the StrongArm Latch	3: Systematic Design
Feb	W	15	16	Wireline and Wireless System Example	3: Systematic Design
Feb	F	17	17	CTLE, FFE and DFE	3: Systematic Design
Feb	M	20	18	Noise, Mismatch and Offset	4: SA Latch, CTLE
Feb	W	22	19	Low-power, Low-noise and Low-voltage	4: SA Latch, CTLE
Feb	F	24	20	Phase Noise and Oscillator basics	4: SA Latch, CTLE
Feb	M	27	21	Review for Mid-Term	
Mar	W	1		**Mid-Term Exam**	
Mar	F	3	22	Oscillator analysis and design	
Mar	M	6	23	VCO and DCO design	5: VCO
Mar	W	8	24	PLL System-level analysis	5: VCO
Mar	F	10	25	PLL trade-offs and advanced designs	5: VCO
Mar	M-F	13-17		**Spring Break: No Class**	
Mar	M	20	26	Filters intro, Active G_m-C Filters	5: VCO
Mar	W	22	27	Examples of G_m-C designs, intro to Sw-Cap	5: VCO
Mar	F	24	28	Sw-Cap Analysis	5: VCO
Mar	M	27	29	Sw-Cap based Circuit Examples	
Mar	W	29	30	**Presentation by Student Groups**	Project Proposal
Mar	F	31	31	**Presentation by Student Groups**	Project Proposal
Apr	M	3	32	ADC Architectures and Trade-offs	6: Sw-Cap PA+TX
Apr	W	5	33	SAR ADCs	6: Sw-Cap PA+TX
Apr	F	7	34	Sigma-Delta ADCs	6. Sw-Cap PA+TX
Apr	M	10	35	Advanced ADC Designs	
Apr	W	12	36	CDR intro	
Apr	F	14	37	CDR Analysis and Design	
Apr	M	17	38	Other Clocking Considerations	
Apr	W	19	39	**Presentation by Student Groups**	Project Presentation
Apr	F	21	40	**Presentation by Student Groups**	Project Presentation
Apr	M	24	41	Advanced BJT Applications	
Apr	W	26	42	Final Review	Project Submission

Final Exam Date and Place: TBD (Please keep an eye on Canvas/one.uf)
** This syllabus is subject to revision **

Electrical & Computer Engineering

UF UNIVERSITY of FLORIDA
The Foundation for The Gator Nation

EEE 6321 Analog IC Design 2

Spring 2023

Description: Advanced Graduate course on Analog IC Design (3 credits).

Prerequisites: EEE 5320 Analog IC Design 1 (or similar – with consent of the Instructor)

Class times: MWF 3rd period (09:35 – 10:25 AM) **Room**: CSE E118

Instructor: Baibhab Chatterjee (chatterjee.b@ufl.edu)

TAs: TBD

Course Organization: Each major topic will include homework assignments (theory and/or simulations) emphasizing practical applications. There will be 6 homeworks (the lowest grade will be dropped), 1 mid-term exam, 1 term project and 1 final exam.

Textbook:

P. E. Allen and D. R. Holberg, *CMOS Analog Circuit Design*, 3rd Ed., New York Oxford University Press (2012). A Digital Copy is available for free in UF Libraries.

References (recommended):

1. B. Razavi, *Design of Analog CMOS Integrated Circuits*, 2nd Ed., McGraw-Hill Education (2016) ISBN-10: 0072524936 ISBN-13: 978-0072524932. Link to Amazon.
2. T. Carusone, D. Johns, K. Martin, *Analog Integrated Circuit Design*, 2nd Ed., Wiley, 2011;
3. J. Baker, *CMOS Circuit Design, Layout and Simulation*, IEEE Press/Wiley;
4. Excerpts from several sources as provided in class.

Grading:

HW (6@10% each):	50% (drop lowest one)
Term Project:	25%
Mid-Term Exam:	10%
Final Exam:	15%

Letter Grade Policy (tentative, and subject to change based on class distribution):

92.5% - 100%	A (4.0)
90% - 92.499..%	A- (3.67)
87.5% - 89.999..%	B+ (3.33)
82.5% - 87.499.. %	B (3.0)
80% - 82.499..%	B- (2.67)
75% - 79.999.. %	C+ (2.33)
Below 75%	At Instructor's Discretion

Instructor Office Hours:

Office Hours: MWF, 10:45 - 11:15 AM, NEB 533
Additional Zoom Link for Office Hours:
https://ufl.zoom.us/j/99287797382?pwd=bGlDWjMyU1ZiSVZBbFFjcDhMUTM1Zz09

Course Themes:
· Practical Analog IC Design: How do you make analog circuits to do useful things?
· Trade-offs in Analog Systems
· Design-oriented analysis

Homework Assignments: A max of total 6 homework assignments over the semester

- Usually assigned on a Monday; due by 1 or 2 weeks, depending on the complexity.
- Goals: 1) to illustrate and reinforce lecture topics, 2) provide practice questions for mid-term/final exams, 3) circuit trade-off analysis and building intuitions through simulations.
- Lowest score will be dropped
- It's OK to work in groups or to get tips from other students; but you must turn in your own work for final grading.
- You won't learn as much from the homework if you depend on somebody else to tell you how to do it. But feel free to discuss/ask questions to the instructor.
- Turn in homework online in Canvas as .pdf or .doc. Alternatively, directly email the instructor at chatterjee.b@ufl.edu. All emails should have "EEE 6321" in the subject line.
- Late penalty policy for homeworks: 5% credit will be reduced each day after the deadline.
- Turning in homework late based on any published solution could be considered as cheating, and can carry higher penalties.

Term Project:

- 3-4 topics will be provided in class. You can choose any one out of those topics, or propose your own project.
- Working in groups is highly encouraged. Group size could be anywhere between 3-6, depending on the complexity of the project and the work division. Large-sized groups need to justify their choice during the project proposal phase.
- During the proposal phase, focus on: 1. What problem you are trying to solve, 2. What are the existing approaches (literature survey/state-of-the-art), 3. Choice of solution (could be one from literature/your own), 4. Expected trade-offs, 5. Task division among group members, 6. Preliminary Results, 7. Conclusions
- During the final presentation, please include: 1. What problem you are trying to solve, 2. What are the existing approaches (literature survey/state-of-the-art), 3. Design-space exploration and trade-off analysis, 4. Choice of solution based on your analysis (could be one from literature/your own), 5. Observed Trade-offs based on any specific Design Assumptions, 6. Final Results, 7. Comparison with the state-of-the-art, 8. Conclusions, 9. Task division among group members..
- Evaluation Rubric: 20% for the proposal presentation (5% for Describing the motivation, 10% for literature survey and 5% for expected trade-offs from intuition), 80% for the final presentation and documentation (5% for Describing the motivation, 10% for literature survey, 15% for design space exploration, 15% for trade-off explanation, 10% for analysis and simulation methods, 10% for results and explanation, 15% for documentation).
- Student Contribution verification: 1-slide Declaration by the group presenting the topic
- Further details will be provided after Spring Break.

Class Meetings:

Class Participation: The lectures will be in-person. However, previous year's recorded videos will also be made available through mediasite, whenever required. It is strongly encouraged to attend the in-person lectures so you can ask questions and participate in the class. For certain scenarios when the instructor is traveling, classes will be arranged through Zoom and will be notified ~1week early.
Zoom Etiquette, whenever applicable:
I can teach more effectively if you keep your video on and audio off during lectures.

Handouts: I put as much as possible in the notes, but the lectures usually cover more.
Problems: Work as many as you can find, this is the best possible test preparation.
Supplementary problems: Sometimes we can help find more; try assigning yourself design problems and look at reference/other books.

SPICE Assignments:

- LTSpice. Download from http://www.linear.com/designtools/software/
- Cadence login details will be provided before Homework #1
- Have fun with this interactive online circuit simulator: https://everycircuit.com/

Course Evaluation

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at https://gatorevals.aa.ufl.edu/students/. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via https://ufl.bluera.com/ufl/. Summaries of course evaluation results are available to students at https://gatorevals.aa.ufl.edu/public-results/.

Timing issues for online/EDGE students:

EDGE policy requires that quizzes and homeworks should be graded and returned within one week after you turn them in. We usually do much better than that. On the other hand, EDGE policy also requires that you should not fall more than one week behind real time. In principle, I'm not worried about exactly when you turn in the assignments, as long as it's less than one week behind real time. However, you can't progress in the class (watch all of the videos) until you've turned in the homework. Of course, one of the nice things about taking this course online is that if family or work issues force you to take an extra day or two, then you have that freedom. In effect, you have a "buffer" that you can use to allow some "slack." If you fall behind more than a few days, you get in danger of losing touch with the class, so you should avoid that. If you get a whole week behind, then you've lost your "buffer". Please let me know if you're going to be more than a few of days behind, and then you need to catch up as soon as you can to restore your flexibility. The one-week limit applies to exams as well, with the same strong suggestion not to fall that far behind.

Academic Honesty Policy:

You are not allowed to cheat or to tolerate cheating. The University's honesty policy, which I follow, can be found at https://sccr.dso.ufl.edu/wp-content/uploads/sites/4/2018/08/The-Orange-Book-Web.pdf.

You may consult with other students on homeworks or projects. However, solutions or reports that you turn in must be **your work alone**. For example, you must create your own computer files and run your own simulations.

- You are expected to do your own work.
- You are expected to report any violations of the Honor Code that you become aware of.
- It is a violation of the Honor Code to turn in solutions to homeworks, labs or tests copied from other students or from published handouts or solutions.
- You are welcome to work with other students on homeworks and lab reports. However, once you understand the method of solution you should work through the calculations yourself.

How to study for this course:

The best way to learn how to analyze circuits and to prepare for tests is to *practice*. There are at least two sets of skills that you must master. One is figuring out how to approach an unfamiliar circuit or problem; the other is how to work through the solution to the problem or the analysis. If you always get help with setting up the problem, or just watch someone else solve the problem, you do not get any practice at all. To learn this material and to do well in the course, you must work problems and analyze circuits by yourself.

Disabilities Accomodations:

Students requesting classroom accommodation must first register with the Dean of Students Office. The Dean of Students Office will provide documentation to the student who must then provide this documentation to the Instructor when requesting accommodation.

UF Religious Holiday Policy:

"Students, upon prior notification of their instructors, shall be excused from class or other scheduled academic activity to observe a religious holy day of their faith. No major test, major class events or major university activity should be scheduled on a major religious holiday. Professors and university administration shall not penalize students who are absent from academic or social activities because of religious observance. Students shall be permitted a reasonable amount of time to make up material or activities covered in their absence."

To excuse religious holidays, students need to give the instructor a 1 week notice prior to the specific holiday.

UF Counseling Services:

Resources are available on-campus for students having personal problems or lacking clear career and academic goals. Resources include:

· University Counseling Center, 301 Peabody Hall, 392-1575, Personal and Career Counseling.

· SHCC Mental Health, Student Health Care Center, 392-1171, Personal and Counseling.

· Center for Sexual Assault/Abuse Recovery and Education (CARE), Student Health Care Center, 392-1161, sexual assault counseling.

· Career Resource Center, Reitz Union, 392-1601, career development assistance and counseling.

Software Use and Pledge:

All faculty, staff and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. "We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity."

Make-Up Opportunities:

It is very hard for me to make you a customized exam. However, with a University-approved excuse and arranged for in advance, or in an emergency, a make-up exam will of course be allowed and accomodated.

Further Details:

Attendance Policy, Class Expectations, and Make-Up Policy

Excused absences must be consistent with university policies in the Graduate Catalog (https://catalog.ufl.edu/graduate/regulations) and require appropriate documentation. Additional information can be found here: https://gradcatalog.ufl.edu/graduate/regulations/

In-Class Recording

Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A "class lecture" is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To "publish" means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

University Honesty Policy

UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor Code (https://sccr.dso.ufl.edu/process/student-conduct-code/) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- Jennifer Nappo, Director of Human Resources, 352-392-0904, jpennacc@ufl.edu
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Campus Resources:

Health and Wellness

U Matter, We Care:
Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: https://counseling.ufl.edu, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence
If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)
Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or http://www.police.ufl.edu/.

Academic Resources

E-learning technical suppor*t*, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. https://lss.at.ufl.edu/help.shtml.

Career Connections Center, Reitz Union, 392-1601. Career assistance and counseling; https://career.ufl.edu.

Library Support, http://cms.uflib.ufl.edu/ask. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring. https://teachingcenter.ufl.edu/.

Writing Studio, 302 Tigert Hall*,* 846-1138. Help brainstorming, formatting, and writing papers. https://writing.ufl.edu/writing-studio/.

Student Complaints Campus*:* https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/;https://care.dso.ufl.edu.

On-Line Students Complaints*: https://distance.ufl.edu/state-authorization-status/#student-complaint*.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: https://registrar.ufl.edu/ferpa.html