FACULTY MENTOR
Prasad Gudem

PROJECT TITLE
Analog/RF Integrated Circuit Design

PROJECT DESCRIPTION
Description: Analog/RF Integrated Circuit Design Using BEOL Ferroelectrics. Ferroelectrics have recently received significant attention due to their application in negative-capacitance, field-effect transistors (NCFETs), which have emerged as a possible candidate for breaking the 60mV/decade sub-threshold slope barrier and operating at low supply voltages and improved RF performance [1, 2]. Unfortunately, over a decade of research on the integration of ferroelectrics in the FEOL to fabricate NCFETs has proven challenging.

However, fabrication of ferroelectrics in the BEOL has been successfully demonstrated. Recently, we have shown that BEOL ferroelectrics can used to improve the analog/RF performance of conventional MOSFETs in integrated circuits [4]. The key to our approach is the use of active feedback in addition to capacitance matching to stably hold the ferroelectric in its negative-capacitance regime, and thus achieve the capacitance cancellation required to reduce the input capacitance. The approach is illustrated in our work by a new P-NCFET structure that achieves significantly higher fT and gm*fT/ID, key metrics for analog/RF performance. The next phase of the research involves designing representative RF circuits using BEOL FE and evaluate the analog/RF performance. Note that there are several other projects that will be discussed with interested students.

This project can accommodate both remote and in-person students.

INTERNS NEEDED
3 Students

PREREQUISITES
1. Highly motivated 1st year MS student interested in doing research in RFIC design.
2. Students must be enrolled in ECE166 and ECE164 and scheduled to take ECE265 course sequence.
3. Prior experience in using Cadence, publications in IEEE and/or prior industry experience in analog IC design is an asset.
4. Interested students can contact Prof. Prasad Gudem (pgudem@ucsd.edu).

References:

[1] J. K. Wang, P. Gudem, T. Cam, Z. Yuan, M. Wong, K. Holland, D. Kienle and M. Vaidyanathan "RF Performance Projections of Negative-Capacitance FETs: fT, fmax, and gm*fT/ID," IEEE Transactions on Electron Devices, 2020.

[2] Z. Yuan, P. Gudem, J. Wang, T. Hook, P. Solomon, D. Kienle, and Mani Vaidyanathan, "Toward microwave S- and X-parameter approaches for the characterization of ferroelectrics for applications in FeFETs and NCFETs," IEEE Transactions on Electron Devices, 2019.

[3] Z. Yuan, P. Gudem, A. Aggarwal, C. VanEssen, D. Kienle, and M. Vaidyanathan, "Feedback Stabilization of a Negative-Capacitance Ferroelectric and its Application to Improve the fT of a MOSFET," IEEE Transactions on Electron Devices, 2021.

Biography:

Prasad Gudem received a B. Tech degree in Electrical Engineering from the Indian Institute of Technology, Madras, India in 1988 and a Ph.D. degree in Electrical Engineering from the University of Waterloo, Waterloo, Ontario, Canada in 1996. He was Vice President of Engineering at Qualcomm until 2018 and led the development of multiple generations of cellular transceivers that sold over one billion chips and used in top-tier products such as iPhone, Samsung, etc. He is currently an Adjunct Professor in the Department of Electrical and Computer Engineering, University of California at San Diego, La Jolla, CA, USA. He has 50+ patents and 50+ IEEE publications. Dr. Gudem was the recipient of the Graduate Teaching Award in recognition of his outstanding teaching of the ECE265 course sequence, "Communication Circuit Design: I, II, and III". He is an avid follower of the history of STEM and a boomerang sports enthusiast.

FACULTY MENTOR
Prasad Gudem

PROJECT TITLE
Study of Aerodynamics of Boomerangs and Drones Using Wireless Position Location

PROJECT DESCRIPTION
Description: Analog/RF Integrated Circuit Design Using BEOL Ferroelectrics. Ferroelectrics have recently receThe boomerang is a simple and ingenious device invented by man thousands of years ago. Despite the simplicity of the device, the flight dynamics of a boomerang is rather complex as it experience significant translational and rotational velocity. In our recent publications, we extended Vassberg's work on the flight dynamics of boomerangs by including the impact of reversal of airflow and reversal of angle-of-attack [1, 2, 3]. A meshed ultra-wideband wireless tracking system with 16 anchors on the ground along with a tag mounted on the boomerang was used to accurately track the flight trajectory of the boomerang. The simulation results are compared with flight trajectory measurements. Our research group is in the process of extending our earlier research to study the impact of joint angle, dihedral, on the flight trajectory of the boomerang using an improved ultra-wideband wireless position location system and micro-mechanical. These results will then be used to enhance the existing knowledge on the flight dynamics of boomerangs and drones.

This project can accommodate both remote and in-person students.

INTERNS NEEDED
3 Students

PREREQUISITES
1. Designing PCBs, Basic knowledge of Electronics, Experience in Matlab, etc.

References:

[1] John Vassberg, “Boomerang Flight Dynamics,” 30th AIAA Applied Aerodynamics Conference, 2012.

[2] P. Gudem, M. Schütz, K. Holland, “Flight Dynamics of Boomerangs: Impact of reversal of airflow and reversal of angle of attack”, AIAA Aviation Forum and Exposition, 2019.

[3] P. Gudem, M. Laslett, G. Carfano, M. Schütz, K. Holland and H. Murguia, “Flight Dynamics of Boomerangs: Impact of Drag Force and Drag Torque”, AIAA Aviation Forum and Exposition, 2020.

Biography:

Prasad Gudem received a B. Tech degree in Electrical Engineering from the Indian Institute of Technology, Madras, India in 1988 and a Ph.D. degree in Electrical Engineering from the University of Waterloo, Waterloo, Ontario, Canada in 1996. He was Vice President of Engineering at Qualcomm until 2018 and led the development of multiple generations of cellular transceivers that sold over one billion chips and used in top-tier products such as iPhone, Samsung, etc. He is currently an Adjunct Professor in the Department of Electrical and Computer Engineering, University of California at San Diego, La Jolla, CA, USA. He has 50+ patents and 50+ IEEE publications. Dr. Gudem was the recipient of the Graduate Teaching Award in recognition of his outstanding teaching of the ECE265 course sequence, “Communication Circuit Design: I, II, and III”. He is an avid follower of the history of STEM and a boomerang sports enthusiast.