



Course Syllabus: Special Topics in Circuits - EE 390AA

Division	Computer, Electrical and Mathematical Sciences & Engineering
Course Number	EE 390AA
Course Title	Special Topics in Circuits
Academic Semester	Fall
Academic Year	2019/2020
Semester Start Date	08/25/2019
Semester End Date	12/10/2019
Class Schedule (Days & Time)	02:30 PM - 04:00 PM Mon Wed

Instructor(s)				
Name	Email	Phone	Office Location	Office Hours
Hossein Fariborzi	hossein.fariborzi@kaust.edu.sa	+966128087302	3275, 3, Ibn Sina (bldg. 3)	Email hossein.fariborzi@kaust.edu.sa for appointments.

Teaching Assistant(s)	
Name	Email

Course Information	
Comprehensive Course Description	This course investigates the emerging technologies for computing and digital, analog and mixed signal circuit design. As the end of Moore's law and aggressive scaling of CMOS transistors is looming, the chip industry and academic community is in search of the next generation of switching and memory devices. In this course we take a closer look at more than 20 emerging technologies, such as MEMS/NEMS, TFET, carbon nanomaterial devices, spin-based logic/memory, ReRAM, CBRAM, PCM, piezotransistors, microresonator based logic, etc and explore the new circuit design paradigms tailored for them. Emerging architectures, non-Von Neuman/neuromorphic/brain-inspired computing solutions will also be covered.
Course Description from Program Guide	
Goals and Objectives	<ul style="list-style-type: none"> - Getting familiar with a broad range of technologies which are posed to replace or complement the current solutions for integrated circuit design - Learning the pros and cons of each technology, the circuit design space and specific applications in which they are relevant. - Learning different circuit design techniques, paradigms and architectures that suit each technology.
Required Knowledge	Basics of CMOS digital/analog circuit design and CMOS technology
Reference Texts	Optional: CMOS and Beyond: Logic Switches for Terascale, by Tsu-Jae King Liu, Kelin Kuhn
Method of evaluation	20.00% - Midterm exam 40.00% - Final exam 40.00% - Course Project(s)

Nature of the assignments	A main course project that revolves around the technology of interest for each student. The project is divided into different parts and is done in multiple stages, starts from the technology and ends with application/system design based on the technology.
Course Policies	Late submission is not accepted.
Additional Information	

Tentative Course Schedule

(Time, topic/emphasis & resources)

Week	Lectures	Topic
1	Mon 08/26/2019 Wed 08/28/2019	Moore's law, limits of photolithography and transistor scaling, leakage and the end of CMOS era
2	Mon 09/02/2019 Wed 09/04/2019	An introduction to the new generations of transistors
3	Mon 09/09/2019 Wed 09/11/2019	Charge based emerging technologies 1 HEMT, Gallium Nitride and TFET and Peizotransistor
4	Mon 09/16/2019 Wed 09/18/2019	Charge based emerging technologies 2: Negative capacitance transistors, IMOS, graphene and carbon nanomaterial based devices, 2D channel FET
5	Mon 09/23/2019 Wed 09/25/2019	Saudi National Day Charge based emerging technologies 3: Electromechanical computing : Relays and resonator logic
6	Mon 09/30/2019 Wed 10/02/2019	Charge based emerging technologies 4: Resistive RAM/Memristor, CBRAM, Phase change memory
7	Mon 10/07/2019 Wed 10/09/2019	Circuit design considerations for charge based technologies
8	Mon 10/14/2019 Wed 10/16/2019	Project overview Midterm
9	Mon 10/21/2019 Wed 10/23/2019	An introduction to spintronics for logic and memory design Case study and project discussion
10	Mon 10/28/2019 Wed 10/30/2019	Spin-based logic and memory design solutions
11	Mon 11/04/2019 Wed 11/06/2019	Project presentation (2) and final design discussion
12	Mon 11/11/2019 Wed 11/13/2019	Hybrid multi-technology design Overview of their technologies
13	Mon 11/18/2019 Wed 11/20/2019	non-Von Neuman machine: Neuromorphic/brain-inspired computing 1
14	Mon 11/25/2019 Wed 11/27/2019	non-Von Neuman machine: Neuromorphic/brain-inspired computing 2 Final presentations
15	Mon 12/02/2019 Wed 12/04/2019	Exam on 12/2/19
16	Mon 12/09/2019	End of semester

Note

The instructor reserves the right to make changes to this syllabus as necessary.