San José State University
School/Department
Course Number, Title, Section, Semester, Year

Course and Contact Information

Instructor: Marshall Wang

Office Location: EE383

Telephone: (408) (823-2266)

Email: mingshan.wang@sjsu.edu

Office Hours: Tuesday & Thursday 7:15pm to 7:45pm

Class Days/Time: Tuesday & Thursday 6:00pm to 7:15pm

Classroom: Hugh Gills Hall 217

Course Description

The radio frequency integrated circuit design 1 (RFIC Design I) is an introductory graduate level course which covers topics of wireless transceiver architectures, RF modeling of transistors and integrated components including planar inductors, capacitors and transformers in submicron CMOS and Bipolar processes, network theory, S-parameters, power gains of 2-port networks, lumped transmission lines, impedance matching and concepts such as compression, intercept points, inter-modulation distortion and link budgets of transmitter, as well as phase noise, noise figure and link budgets of receiver.

Course Learning Outcomes (CLO)

- Students will be able to design wireless communication link budget and understand key RF parameters.
- Students will be able to understand the concept of wave propagation, loss, device noise, noise figure, and nonlinearity effects in transmitter.
- Students will be able to use Smith Chart to design impedance matching network.
- Students will be able to understand and use S-parameters for 2-port network analysis.
- Students will have sufficient RFIC design foundation to continue the next RFIC Design II (EE230).

Upon successful completion of this course, students will be able to:

1. CLO 1 Understand the application and key RFIC design parameters
2. CLO 2 Understand basic radio transceiver architecture and wireless communication
3. CLO 3 Understand device nonlinearity effects such as gain compression, inter-modulation
4. CLO 4 Understand the noise impact to receiver and how the noise figure is defined and calculated
5. CLO 5 Understand the S-parameters, matching networks, and Smith Chart

Required Texts

- B. Razavi, RF Microelectronics, 2nd Edition, Upper Saddle River, New Jersey, Prentice Hall, 2012.

Suggested Reference Materials for Extra Readings:

- T. H. Lee, The Design of CMOS Radio Frequency Integrated Circuits, Cambridge, U.K., Cambridge University Press, 2004.
- D.M. Pozar, Microwave Engineering, New York, John Wiley, 2004.
- Selected publications from journal of solid-state circuits (JSSC), transactions on microwave theory and techniques (MTT), international solid-state circuit conference (ISSCC) and custom integrated circuits conference (CICC). Papers can be downloaded from IEEE xplore website.

Course Requirements and Assignments

SJSU classes are designed such that in order to be successful, it is expected that students will spend a minimum of forty-five hours for each unit of credit (normally three hours per unit per week), including preparing for class, participating in course activities, completing assignments, and so on. More details can be found from University Syllabus Policy S16-9 at http://www.sjsu.edu/senate/docs/S16-9.pdf.

NOTE that University policy F69-24 at http://www.sjsu.edu/senate/docs/F69-24.pdf states that "Students should attend all meetings of their classes, not only because they are responsible for material discussed therein, but because active participation is frequently essential to insure maximum benefit for all members of the class. Attendance per se shall not be used as a criterion for grading."

Final Examination or Evaluation

The dates of exams are shown on the course syllabus. There will be no make-up exam and those absent will receive no credit. Students must write their answers clearly in an organized fashion. Further instructions will be provided during exams.

Note that "All students have the right, within a reasonable time, to know their academic scores, to review their grade-dependent work, and to be provided with explanations for the determination of their course grades." See University Policy F13-1 at http://www.sjsu.edu/senate/docs/F13-1.pdf for more details.

Grading Information

Mid-term Exam	35%
Final Exam	45%
Individual Design Project	20%

Determination of Grade

100% - 90%	A	71.9% - 69%	C
89.9% - 85%	A-	68.9% - 65%	C-
84.9% - 82%	B+	64.9% - 62%	D+
81.9% - 79%	B	61.9% - 59%	D
78.9% - 75%	B-	58.9% - 55%	D-
74.9% - 72%	C+	54.9% and below	F

Classroom Protocol

1. Attend all class meetings on time
2. Focus in the lecture without private conversation and cell phone communication
3. Treat all in class with respect

University Policies

Per University Policy S16-9, university-wide policy information relevant to all courses, such as academic integrity, accommodations, etc. will be available on Office of Graduate and Undergraduate Programs' Syllabus Information web page at http://www.sjsu.edu/gup/syllabusinfo/"

EE220 / RFIC Design I, Fall 2016, Course Schedule

The following schedule is subject to change with fair notice to student's email.

Course Schedule

Week	Date	Topics, Readings, Assignments, Deadlines
1	8/25	Introduction to RFIC design and its Challenges
2	8/30	Key RFIC Parameters and Specification
2	9/1	Link Budget and Communication Distance
3	9/6	General Consideration in RF Design
3	9/8	dB, dBm, and dBc
4	9/13	MOS Device Nonlinearity
4	9/15	Harmonic Distortion Due To Nonlinearity
5	9/20	Gain Compression Point
5	9/22	Inter-Modulation Due to Nonlinearity
6	9/27	Third Intercept Point (IP3)
6	9/29	IIP3 and OIP3
7	10/4	Cascaded Nonlinearity
7	10/6	IM Spectra in a Cascade
8	10/11	Mid-term review
8	10/13	Mid-term Exam
9	10/18	Noise and its Spectrum
9	10/20	Device Noise (Current Source and Voltage Source)
10	10/25	Definition of Noise Figure
10	10/28	Noise Figure of Cascaded Stages
11	11/1	Noise Figure of Cascaded Stages – Design Example

Week	Date	Topics, Readings, Assignments, Deadlines
11	11/3	Noise Figure of Lossy Circuits
12	11/8	Receiver Sensitivity
12	11/10	Dynamic Range of Receiver
13	11/15	Series-to-Parallel Conversion
13	11/17	Matching Network and Its Loss
14	11/22	Scattering Parameters (S11, S12, S22, S21)
14	11/24	No class – Thanksgiving Holiday
15	11/29	Smith Chart and VSWR
15	12/1	L and C Matching Examples
16	12/6	Antenna Matching Using Smith Chart
16	12/8	Final exam review
Final Exam	12/15	6:10PM – 7:10PM in class room