# Course Outline ELEC 5503 RFIC Design

**Schedule:**

Carleton University, Fri., 2:35-5:35, Sept - Dec. 2025

**Outline:**

This course is for IC designers who would like to become familiar with the design of integrated radio front-end circuits. The first part of the course deals with general topics such as impedance matching, noise, linearity, stability, the use of simulators, and layout consideration. The second part of the course deals with detailed design of some radio front-end circuits, such as low-noise amplifiers, mixers, voltage-controlled oscillators and power amplifiers. **Course Content**

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1. **General Discussion:** link budgets, filtering considerations, matching, use of Smith Charts, intermodulation, intercept points (IP3), compression, noise figure, sources of noise, stability, simulation issues, packaging, printed circuit boards; layout concerns such as isolation, coupling, matching, parasitics, shielding; components such as transistors, capacitors, resistors, inductors, baluns, interconnect.
2. **LNA Design:** simple, cascode, tuned, balun coupled, noise, linearity, signal levels, gain, frequency response, biasing, power dissipation broadband design, UWB, distributed amplfiers
3. **Mixer Design:** Gilbert cell, use of inductors and baluns, balanced, doubly balanced, singlesideband, image-reject mixers, noise, linearity, signal levels, conversion gain, frequency response, feedthroughs, power dissipation, simulation issues, passive mixers, subsampling mixers.
4. **VCO Design:** types, resonators, varactors, phase noise, signal levels, frequency, tuning methods and tuning range, startup time, frequency switching speed, isolation from other circuits, injection locking, power dissipation, simulation issues
5. **Power Amplifier Design:** different classes, efficiencies, output power, power control, packaging issues, simulation issues, linearization. 6. **Examples: from research and literature**

**Marks:**

Marks will be based on four assignments worth 70% and a final exam, worth 30% of the final mark. Assignments involve design of an LNA, a mixer, a VCO, and a power amplifier, through simulation using a commercial process and SpectreRF from Cadence

**SpectreRF tutorial and further information** The process we are using is proprietary. We have permission to use it for the course, provided students sign a non-disclosure agreement. However, we are not allowed to post any information on public web sites, so all information will be given in class and on private sites.

**Text Book:**

**John Rogers and Calvin Plett, *Radio Frequency Integrated Circuit Design 2nd Ed.,*** Artech House, 2010, ISBN 978-1-60783-979-8. Available from the publishers at US$149, and elsewhere, (often at lower price elsewhere) but likely you best price is to get it as part of the course from the course instructor at cost price. Should be available by the first week in Feb.

**References:**


**Behzad Razavi**, ``RF Microelectronics", Prentice-Hall 1998, ISBN 0-13-887571-5, **Thomas H. Lee**, ``The Design of CMOS Radio-Frequency Integrated Circuits, second edition", Cambridge University Press, 2004.

**Jan Crols, Michiel Steyaert**, ``CMOS Wireless Tranceiver Design," Kluwer Academic Publisher, 1997.

**Assad Abidi, Paul R. Gray,** Editors, "Integrated Circuits for Wireless Communications", Collection of papers from IEEE Press,

**Steve Cripps** , ``Rf Power Amplifiers For Wireless Communications," Artech House 1999. ISBN 0890069891

**Stephen A. Maas** , ``Microwave Mixers," Second Edition, Artech House 1993.

**Stephen A. Maas** , ``The RF and Microwave Circuit Design Cookbook," Artech House 1998.

**Lawrence E. Larson**, ``RF and Microwave Circuit Design for Wireless Communications," Artech House, 1996.

**James S. Ussailis**, ``RF Circuits and Layout for Wireless Communications", McGraw-Hill, 1998.

**Gonzalez**, ``Microwave Transistor Amplifiers", Second Edition, Prentice-Hall 1997.

**Hagen**, ``Radio Frequency Electronics", Cambridge University Press 1996.

**Joseph J. Carr**, ``Secrets of RF Circuit Design", McGraw-Hill, (books.com says Tab Books), 1996.

**Chris Bowick**, ``RF Circuit Design", Butterworth-Heinemann 1997 (Reprint of 1982 book? Not sure if updated) .

**Davidse**, ``Analog Electronic Circuit Design", Prentice-Hall 1991.

**Pederson**, ``Analog Integrated Circuits for Communication" Kluwer 1991.

**Grebene** and **Gray**, Meyer, general references for design of analog integrated circuits. **Jack Smith** and **Krauss, Bostian, Raab**, general references for design of communication circuits.