Engineering Tripos Part IIB, 4B21: Analogue Integrated Circuits, 2017-18

Module Leader

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Lab Leader

Dr S Sambandan

Timing and Structure

Michaelmas term. 16 lectures (including examples classes and case studies). Assessment: 100% exam

Prerequisites

3B1, 3B2, 3B5 assumed; 3B3, 3B6 useful

Aims

The aims of the course are to:

- provide a firm foundation and problem-solving skills for students to design and analyze complementary metal oxide semiconductor (CMOS) analog circuits.

Objectives

As specific objectives, by the end of the course students should be able to:

- understand the design process for bipolar and MOS, including CMOS, integrated circuits.
- have developed an awareness of the requirements in designing circuits in IC technology.
- understand how CMOS scaling affects analogue circuit design.
- design current sources and biasing stages of multi-stage amplifier circuits.
- demonstrate a knowledge of the factors limiting high frequency behaviour of circuits.
- design and analyse integrated operational amplifier circuits.
- understand noise sources in circuits and compute signal to noise ratio and equivalent input noise.
- demonstrate knowledge of the effect of feedback on circuit operation and stability.

Content

The purpose of this module is to provide firm foundation and problem-solving skills for students to design and analyze complementary metal oxide semiconductor (CMOS) analog circuits. It will cover the major aspects of the design and fabrication of analogue integrated circuits and is intended to make graduates become more competitive to a large industrial segment looking for circuit designers, especially those skilled in analog and mixed signal circuit design.

This course will cover the major aspects of the design and fabrication of analogue integrated circuits. Topics addressed will include:

- **Integrated Circuit BJT and MOSFET Modeling (1L)**
- biasing and operating regimes, small signal models of BJTs and MOSFETs, short channel effects and scaling, and its impact on small signal parameters
- **Single and Multistage Amplifiers (2 L)**
- small signal single stage amplifier configurations and properties, multistage amplifier stages such as Darlington and cascade configurations, differential amplifiers
- **Current Sources, Loads, and Output Stages (2 L)**
- current mirror configurations, low current biasing sources, current matching considerations, temperature compensation, active load configurations, CMOS integrated amplifiers, emitter and source followers, push-pull stages, CMOS class AB output stages
- **Operational Amplifiers (2 L)**
- input bias current, offset voltage, common-mode rejection ratio, power supply rejection ratio, analysis of the simple op amp, design considerations of integrated op-amps
- **Frequency Response of Analogue Integrated Circuits (2 L)**
- single stage amplifiers, Miller effect, voltage buffers, current buffers, multistage amplifiers, operational amplifiers
- **Feedback and Stability (2 L)**
- feedback configurations, properties, gain-bandwidth product, instability Nyquist criteria, compensation, root locus, slew rate
- **Noise in Integrated Circuits (2 L)**
- noise sources, models, circuit noise, effect of feedback, noise in op-amps, noise figure and noise temperature
- **Nonlinear Analogue Circuits (2 L)**
- oscillators, multipliers and phase-locked loops
- **Application Examples (1 L)**

Booklists

Please see the Booklist for Group B Courses [2] for references for this module.

Examination Guidelines

Please refer to Form & conduct of the examinations [3].

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