**The Hong Kong University of Science and Technology**

**UG Course Syllabus**

Analogue Integrated Circuits Design and Analysis

ELEC 4420

4 Credits

Pre-requisite: ELEC 3400 Introduction to Integrated Circuits Design

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**Course Description**

ELEC4420 is a high-level UG course about the design and analysis of analog integrated circuits. Built on the pre-requisite course, this course focuses on further educating students about the design methodology and analysis method of fundamental of analog circuits. The topics include frequency response, feedback, stability and compensation, and 2-stage OTA design.

**Intended Learning Outcomes (ILOs)**

By the end of this course, students should be able to:

1. Analyze basic analog circuit schematics composed of MOS transistors; know how to compute the gain, bandwidth, input/output voltage range, PSRR, CMRR with a given circuit schematic

2. Design basic analog circuits, including single-stage amplifiers, two-stage amplifiers, reference circuits, etc.

3. Understand what feedback in analog circuits is, identify corresponding feedback types and the sources of instabilities.

4. Understand noise and its origin in analog circuits, calculate noise contribution from different sources.

**Assessment and Grading**

This course will be assessed using criterion-referencing and grades will not be assigned using a curve. Detailed rubrics for each assignment are provided below, outlining the criteria used for evaluation.

**Assessments:**

| Assessment Task | Contribution to Overall Course grade (%) | Due date |
|---|---|---|
| Homework | 20% | 30/11/2024 |
| Mid-Term | 30% | 30/11/2024 |
| Group Final Project | 50% | 20/12/2024 |

* Assessment marks for individual assessed tasks will be released within two weeks of the due date.

**Mapping of Course ILOs to Assessment Tasks**

| Assessed Task | Mapped ILOs | Explanation |
|---|---|---|
| Analyzing analog circuit built with CMOS transistors | ILO1, ILO3, and ILO4 | This task assesses students' ability to analyze analog integrated circuits (ILO 1), with especially emphasis on amplifier's stability (ILO 3) and noise (ILO 4) performance. |
| Designing an amplifier based on given specifications | ILO2, ILO3, and ILO4 | The performance of the design project reflects the student's ability to apply analysis knowledge to design problems (ILO 2), especially since the amplifier needs to be stable (ILO 3) and demonstrates low noise (ILO 4). |

**Grading Rubrics**

| Task | Excellent (4) | Good (3) | Satisfactory (2) | Absent (1) |
|---|---|---|---|---|
| Analog CMOS circuit analysis | Can derive important circuit metrics, including gain, bandwidth, input/output voltage range, input/output referred noise, phase margin, etc., of a circuit from transistor parameters correctly. | Can derive important circuit metrics and know how to verify the results through simulation. | Understand important circuit metrics. Knows the method of how to derive them. | Shows a lack of knowledge about circuit metrics or do not know how they correlate with transistor parameters. |
| Analog CMOS circuit design | Can design an amplifier using transistors from a given technology to meet the target specifications. | Can design an amplifier using transistors from a given technology with a few specifications not met. Can propose potential solutions to improve the performance. | Can design an amplifier using transistors from a given technology, and understands what specifications are not met. Can propose potential solutions to improve the performance. | Do not know how to arrange transistor topologies to build amplifiers. |

**Final Grade Descriptors:**

| Grades | Short Description | Elaboration on subject grading description |
|---|---|---|
| A | Excellent Performance | Demonstrates a comprehensive understanding of CMOS analog circuits and expertise in amplifier design. Develops a systematic engineering methodology to optimize the performance of analog circuits. Exhibits a high capacity for scholarship and collaboration, going beyond core requirements to achieve learning goals. |
| B | Good Performance | Shows good knowledge and understanding of CMOS analog circuits and can design amplifiers that meet the specification. Knows how to optimize the performance of amplifiers. Displays motivation to learn and the ability to work effectively with others. |
| C | Satisfactory Performance | Possesses adequate knowledge of CMOS analog circuits and knows how to use the tools to design amplifiers. Understand the specifications of an amplifier. Shows persistence and effort to achieve broadly defined learning goals. |
| D | Marginal Pass | Has threshold knowledge of CMOS analog circuits, potential to apply the knowledge in amplifier designs, and the ability to spot trade-offs in engineering problems. Benefits from the course and has the potential to develop in the discipline. |
| F | Fail | Demonstrates insufficient understanding of CMOS analog circuits and lacks the necessary design skills. Shows limited ability to think critically or analytically and exhibits minimal effort towards achieving learning goals. Does not meet the threshold requirements for professional practice or development in the discipline. |

**Course AI Policy**

The students can use generative AI for homework assignments and final projects. However, the students should be aware that AI generated answers may trigger academic integrity checks by the instructor/TA, as they may look similar to other students AI generated answers.

**Communication and Feedback**

Assessment marks for individual assessed tasks will be communicated via Canvas within two weeks of submission. Detailed feedback on assignments will be provided upon reasonable enquiry. Students who have further questions about the feedback including marks should consult the instructor within five working days after the feedback is received.

**Resubmission Policy**

The students have 1 chance to submit the homework no later than 72 hours after the deadline. There will be no resubmission opportunities for the group final project.

**Required Texts and Materials**

B. Razavi, Design of Analog CMOS Integrated Circuits, Mc-Graw Hill, 2$^{nd}$ ed., 2016

P. R. Gray, P. J. Hurst, S. H. Lewis, and R. G. Meyer, Analysis and Design of Analog Integrated Circuits, Wiley, 5th ed., 2010

**Academic Integrity**

Students are expected to adhere to the university's academic integrity policy. Students are expected to uphold HKUST's Academic Honor Code and to maintain the highest standards of academic integrity. The University has zero tolerance of academic misconduct. Please refer to Academic Integrity | HKUST – Academic Registry for the University's definition of plagiarism and ways to avoid cheating and plagiarism.