ANALOG ELECTRONIC CIRCUITS - IITKGP

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PRE-REQUISITES : Electrical technology and, Semiconductor Devices
INTENDED AUDIENCE : B.E/B.Tech,B.Sc in Electrical and Electronics discipline
INDUSTRIES APPLICABLE TO : Semiconductor companies such as, Intel, TI, Analog Devices, NXP, ST-microelectronics, Infineon

COURSE OUTLINE :
This course on Analog Electronic Circuits has been designed primarily as a core course for undergraduate students and, as a refresher course for master level students and circuit designers working in industry. It starts with basic circuit components and circuit concepts and then, gradually moves to practical building blocks of analog electronic systems. In this course, a serious attempt has been made to make a balance between theory and practice so that the discussed circuits can be constructed in an undergraduate level laboratory class and their measured performance can be easily compared with the analytically predicted performance. It helps to build confidence on theory.

The other important feature of this course is, it covers both BJT based circuits and MOSFET based circuits parallel so that similarities and performance differences between these two classes of circuits are understandable. Moreover, the BJT based circuits discussed here can be easily constricted on bread board to verify their characteristic through measurement. On the other hand, analysis of the MOSFET based circuits provides the necessary foundation for Analog VLSI circuit/system design, a next level course in Microelectronics and VLSI Design.

The above mentioned two features make the proposed course unique with respect to the existing NPTEL courses on this topic. Further, the content of the proposed course is well aligned to the content of Analog Electronics course (EC09) under “AICTE Model Curriculum for undergraduate degree in Electronics and Communication Engineering (Engineering & Technology) published in 2018.

ABOUT INSTRUCTOR :
Prof. Pradip Mandal is a professor in the Electronics and Electrical Communication Engineering Department of IIT Kharagpur. He received his PhD degree from Indian Institute of Science, Bangalore in 1999. He has more than seven years of hands-on design experience from three different IC design companies.His research interest is primarily on Analog VLSI circuit design and automation. He has taught a course on Analog Electronic Circuits more than a decade at IIT Kharagpur. Out of his teaching experience, he has developed the course material for the proposed course.

COURSE PLAN :

Week 1**:** Introduction of this course; Objective of the course; Revisit to pre-requisite topics; Starting with simple diode circuit and its analysis.

Week 2: Revisiting BJT - operation and characteristic equations. Revisiting MOSFET - operation and characteristic equations

Week 3: Analysis of simple non-linear circuits (containing one transistor) and introducing the notion of signal amplification. Input-output transfer characteristic of a non-linear circuit. Linearization of input-output transfer characteristic of a non-linear circuit and introducing the notion of small signal equivalent circuit. Small signal models of transistors.

Week 4: Amplifier models (equivalent circuits): voltage amplifier, current amplifier, trans-conductance amplifier and trans-resistance amplifier. Cascading of multiple amplifiers. Common emitter (CE) amplifier – biasing, operation, analysis numerical examples and design guidelines. Common source (CS) amplifier – biasing, operation, analysis, Numerical examples and design guidelines.

Week 5: Frequency response of CE and CS amplifiers. Frequency response of CE and CS amplifiers considering High frequency models of BJT and MOSFET. Limitations of CE/CS amplifiers and hence the need of buffers

Week 6: Common Collector (CC) and Common Drain (CD) amplifiers– biasing, operation, analysis and design. Common Base (CB) and Common Gate (CG) amplifier – biasing, operation, analysis and design.

Week 7: Multi transistor Amplifiers (operation and analysis): CE-CC; CS-CD; CC-CC; Darlington pair; Cascode amplifiers (CS-CB and CS-CG); Amplifier with active load

Week 8: Single-ended signaling vs. differential signaling, Differential amplifier: Basic structure and principle of operation, analysis for differential mode gain, common mode gain, ICMR and output swing

Week 9: Current mirror- operation and analysis, Use of current mirror as bias circuit in amplifiers such as in CE/ CS, CC/CD, CB/CG and Differential amplifier. Use of current mirror as signal mirror.

Week 10: Feedback system: Basic feedback theory; Four different feedback configurations and their characteristics. Effects of feedback on frequency response of an amplifier. Application of feedback in practical circuits.

Week 11: Oscillation in feedback system and oscillation criterion, Stability analysis of a feedback system, Two-stage differential amplifier and its stability analysis in feedback configuration.

Week 12: Oscillator: Phase-shift and LC based sinusoidal oscillators. Comparator. Square wave generator (Optional) : Power efficiency of an amplifier, Different modes of operation of amplifiers and their power efficiency: Class A, Class B, Class AB and Class C