

# CMOS ANALOG CIRCUIT DESIGN

(Elective Subject)

<b>Course Code:</b>	13B1WEC731	<b>Semester:</b>	7 <sup>th</sup> Semester, B. Tech (ECE)
<b>Credits:</b>	3	<b>Contact Hours:</b>	L-3, T-0, P-0

## Course Objectives

The objectives are to study

1. Differential Amplifier
2. Operational amplifier
3. Applications of operational amplifier
4. High gain amplifier architecture
5. Two stage CMOS operational amplifier

## Course Outcomes

After studying this course the students would gain enough knowledge

1. To be aware about the designing of differential amplifier
2. configurations, equivalent circuit, parameters of an operational amplifier
3. regarding various applications of op-amp and compensation technique.
4. what are current amplifiers, output amplifiers and difference between voltage and current amplifiers
5. design of two stage CMOS operational amplifier and its applications.

## Course Contents

Unit	Topics	References (chapter number, page no. etc)	Lectures
<b>1.</b>	Differential Amplifier, Differential amplifier circuit configurations, DIBO, DIUO, SIBO, SIUO, FET Differential Amplifier, Constant current bias bias, current mirror, cascaded differential amplifier, level translator, cascode configuration, op-amp symbol, parameters, equivalent circuit of an op-amp, configurations,	Ramakant A. Gayakwad, Chapter 1-3	10
<b>2.</b>	Block diagram of feedback, voltage series feedback, voltage shunt feedback, differential amplifiers, compensating networks, frequency response of internally compensated op-amps, frequency response of non compensated op-amps, high frequency op-amp equivalent circuit, closed loop frequency response, slew rate.	Ramakant A. Gayakwad, Chapter 4-6	6
<b>3</b>	DC and AC amplifiers, peaking amplifiers, summing, scaling, averaging amplifiers, voltage to current converter, current to voltage	Ramakant A. Gayakwad, Chapter 7-10	8

	converter, integrator, differentiator, half wave circuit, full wave circuit, logarithmic amplifier, antilogarithmic amplifier, filters, oscillators, comparators, Schmitt trigger, voltage to frequency and frequency to voltage converter, A-D and D-A converter, clippers, clampers, switched capacitors, PLL		
4	Differential amplifiers, cascode amplifiers, current amplifiers, output amplifiers, high gain amplifier architectures.	Philip E. Allen, Douglas R. Holberg, Chapter 4-5	12
5	Design of CMOS op-amps, compensation, Design of two- stage op-amps, cascode op-amps, Buffered op-amps, high speed/ frequency op-amps. Differential op-amps, low voltage op-amps, low noise op-amps, high speed comparators	Philip E. Allen, Douglas R. Holberg, Chapter 6-7, Chapter 8	8
<b>Total Number of Lectures</b>			44

## Evaluation Scheme

1. Test 1 :15 marks
2. Test 2 : 25 marks
3. Test 3 : 35 marks
4. **Internal Assessment** : 25 marks
  - 10 Marks : Class performance, Tutorials & Assignments
  - 10 Marks : Quizzes
  - 5 marks : Attendance

## Text Books

1. Ramakant A. Gayakwad, "Op-amps and linear integrated circuits", PHI, 3rd edition.
2. Philip E. Allen, Douglas R. Holberg, "CMOS Analog circuit design", Oxford, 2nd edition.

## Reference Books

1. K. Lal Kishore, "Operational Amplifiers and Linear integrated circuits", Pearson Education Asia, 2nd edition.
2. Adel S. Sedra, K. C. Smith, "Microelectronics Circuits", Oxford 5th edition International Version.