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Certificate

This is to certify that the dissertation entitled "**Applications of VDCC in Analog Circuit Design**" submitted by **Mayank Rawat** in completion of major project dissertation for Master of Technology degree in **VLSI Design and Embedded Systems** at Delhi Technological University is an authentic work carried out by him in under my supervision and guidance.

This is to certify that the above statement made by the candidate is correct to the best of my knowledge.

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I, **Mayank Rawat**, Roll No. **2k13/VLSI/11**, student of **M.Tech (VLSI Design and Embedded Systems)**, hereby declare that the dissertation titled "**Applications of VDCC in Analog Circuit Design**", under the supervision of **Dr. Malti Bansal**, Assistant Professor, Electronics and Communication Engineering Department, Delhi Technological University, in partial fulfillment of the requirement for the award of the degree of Master of Technology, has not been submitted elsewhere for the award of any degree.

I hereby solemnly and sincerely affirm that all the particulars stated above by me are true and correct to the best of my knowledge and belief.

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Mayank Rawat

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Abstract

The present work deals with voltage differencing current conveyor (VDCC) and its application in analog circuit design. There have been several major developments in the area of analog circuits which have taken place during the past four decades. Ever since the introduction of current conveyors as basic building blocks in analog circuit design, there is a bulk of material available about the various active blocks developed past Current Conveyors.

Among various modern active building blocks, Voltage Differencing Current Conveyor is emerging as quite flexible and versatile building block for analog circuit design. The Voltage Differencing Current Conveyor (VDCC) combines the features of two very basic and very important analog building blocks, a second generation current conveyor and an operational transconductance amplifier. The VDCC analog building block can be used to implement almost all basic signal processing applications like summation, difference, multiplication, amplification, filtering, etc.

In this thesis an attempt has been made to highlight the realization of the VDCC active block using MOSFETs and several other applications in analog circuit design. Initially, the AC and DC characteristics of the VDCC active analog block are studied along with the relationships of various input and output currents and voltages. After this, basic circuits like amplifier, differentiator, integrator and grounded/floating inductor have been realized to understand the working of the VDCC active analog block. After this some advanced applications of VDCC analog block are realized like current/voltage mode biquads and oscillators. A voltage-mode VDCC based biquad filter using three active blocks has also been realized. This VDCC based voltage mode biquad filter gives low-pass, band-pass and notch outputs. For these filters the output characteristics and the effects of passive components are studied and sensitivity analysis is done. Apart from the filter realizations current mode and voltage mode oscillators are also realized. The oscillators are tuned to a particular frequency using passive components.

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List of symbols, abbreviations

Symbols	Descriptions
BW	Bandwidth
BPF	Band Pass Filter
CC	Current Conveyor
CCC	Current Controlled Conveyor
CCII	2nd generation Current Conveyor
CDBA	Current Differencing Buffer Amplifier
CDTA	Current Differencing Transconductance Amplifier
CFOA	Current Feedback Operational Amplifier
CFTA	Current Follower Transconductance Amplifier
CMOS	Complementary Metal Oxide Semiconductor
CM	Current Mode
DXCCII	Dual-X Current Conveyor
DDCC	Differential Difference Current Conveyor
DVCC	Differential Voltage Current Conveyor
FTFN	Four Terminal Floating Nullor
f_o	Pole Frequency or 3 dB Frequency
FI	Floating Inductor
g_m	Transconductance
GI	Grounded Inductor
HPF	High Pass Filter
I_i or I_{in}	Input Current
I_o or I_{out}	Output Current
IC	Integrated Circuit
I_b	Bias Current
KHN	Kerwin-Huelsman-Newcomb
LPF	Low Pass Filter
MISO	Multiple Input Single Output
MIMO	Multiple Input Multiple Output

OTA	Operational Transconductance Amplifier
OMA	Operational Mirrored Amplifier
Op-Amp	Operational Amplifier
Q	Quality Factor
SISO	Single Input Single Output
SIMO	Single Input Multiple Output
SR	Slew Rate
THD	Total Harmonic Distortion
TTF	Tow-Thomas Filter
V_i or V_{in}	Input Voltage
V_o or V_{out}	Output Voltage
V_{SS}	Source Supply Voltage
V_{DD}	Drain Supply Voltage
VDCC	Voltage Differencing Current Conveyor
VM	Voltage Mode
Z_i	Input Impedance

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