**REPORT**

**ON**

**COMPUTER PROGRAMME IN PYTHON PROGRAMMING LANGUAGE FOR THE GENERATION OF THE ORDER N AND COEFFICIENTS OF NORMALIZED TRANSFER FUNCTION FOR CHEBYSHEV FILTER**

**By**

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Abstract

This report represents the review analysis of Chebyshev filters. In this report we discuss the designing of the Chebyshev filter and how to obtain the coefficients of the normalized transfer function for Chebyshev filters.

# Introduction

Approximations are mathematical methods used in translating the filter specifications into realizable transfer functions. With these established approximations, a filter designer can choose from it and design a filter with ease. (Dimopoulos)

Filter approximations deal with normalized low pass specifications since they are not easily denormalized but can be transformed to any filter type, such as high pass, band pass, band reject filters.

The Chebyshev approximation is a commonly used approximation.

# The Coefficient

The Chebyshev polynomials can be defined recursively as:

T(x) = 1; T(x) = x;

T (x) = 2XT(x) +T(x);

The coefficients of these polynomials for a function,  f(x), under certain conditions can be obtained by the following integral:

Fixing some integer N, the zeros of T(x) are:

The coefficients can then be calculated to be given by:

# The Chebyshev Polynomial

The nth order Chebyshev polynomial is stated as follows:

Knowledge of the fact that and makes computation of the other values easy by recursion using the formula:

# Roots of Chebyshev Function

The Chebyshev filter has magnitude of:

With n being the filter order, being a parameter which controls the amount of ripple on the pass band and being the upper pass band edge.

The roots of this equation is given by:

Where,

With,

The transfer function can be expressed as:

K is the denominator constant given as:

# Generating the coefficients using Python programming language

The coefficients given in the previous section are more conveniently calculated using a computer program. The program of choice for this project is the python programming language. The integrated development environment(compiler) used is the Visual Studio Code.

# Program Listing

# This code is a routine to generate the

# order n and coefficients of normalized transfer function

# use n = [1-10] and apmax = [0.25,0.5] db

import math

#This function takes the cosine of the x

def test\_func(x):

    return math.cos(x)

def mapper(x, min\_x, max\_x, min\_to, max\_to):

    return (x - min\_x) / (max\_x - min\_x) \* (max\_to - min\_to) + min\_to

def cheb\_coef(func, n, min, max):

    coef = [0.0] \* n

    for i in range(n):

        f = func(mapper(math.cos(math.pi \* (i + 0.5) / n), -1, 1, min, max)) \* 2 / n

        for j in range(n):

            coef[j] += f \* math.cos(math.pi \* j \* (i + 0.5) / n)

    return coef

def main():

    N = 10

    min = 0.25

    max = 0.5

    c = cheb\_coef(test\_func, N, min, max)

    print( "Coefficients:")

    for i in range(N):

        print (" The coefficients of the " + str(i) + " order is " +  str(c[i]))

    return None

main()

# Output

**Coefficients:**

**The coefficients of the 0 order is 1.8537527491576984**

**The coefficients of the 1 order is -0.045694702330087794**

**The coefficients of the 2 order is -0.0036300649019261333**

**The coefficients of the 3 order is 2.9778237366911986e-05**

**The coefficients of the 4 order is 1.18227755158129e-06**

**The coefficients of the 5 order is -5.8179564776938975e-09**

**The coefficients of the 6 order is -1.53977261496685e-10**

**The coefficients of the 7 order is 5.416500581389982e-13**

**The coefficients of the 8 order is 1.0928757898653885e-14**

**The coefficients of the 9 order is 6.002143226879753e-16**

# Conclusion

The program output show high accuracy. It responded fast in calculating the coefficients. The limitation of using this program is the accessibility to the proper ide to run the program. The project points out an advantage the computer has in filter analysis and design.

Java, C#, Matlab, Python are also good substitutes as programming languages used in generating Chebyshev coefficients.

# Reference

<https://math.stackexchange.com/questions/532103/calculation-of-chebyshev-coefficients>