# Optimization

## Assignment 4

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### Q1

Given

Show that the frequency response can be written as:

Where

and

Proof:

The frequency response:

Which can also be written as:

Where

Q.E.D.

### Q2

Given a type I FIR filter with the response of:

Assume we subsample at

We then get:

With weights

we can write the error at each sampled frequency as:

With our constraint we get:

where

which leads us to

### Q3

For the non-standard form of:

We can convert this to standard form by defining

And a slack variable which leads to

and

Q.E.D.

### Q4

For a LP problem of the standard form:

The auxiliary problem is:

We initialize with

If we get as the solution to problem that then is the basic feasible point of the original problem.

### Q5

Matlab



At N=47 we get a delta of 0.88534 which satisfies the constraints since it is smaller than 1.

### Q6

Matlab



### Q7

We will translate the time constraints on the step response

To constraints on the vector **.** To do thiswe will find the linear transform from

Starting from

Going from

So

where

So

Adding this to our previous constraints gives us:

Q.E.D.

### Q8

As seen in the figure below the constraint on the step response reduces oscillations around zero. The initial N1 was 20. It was reduced to 18 in order to comply with frequency constraints.



The absolute difference for the two step responses is:



As I expected the results in the frequency domain and the impulse response are similar to each other:



### Q9

For the following inequality

Where and can be written as column vectors stacked row wise

,

We will calculate the gradient the following barrier function:

First we shall find the gradient for

For the Hessian first find

We shall define a diagonal matrix

### Q10

The Primal problem is

The Dual problem is:

The Langrangian for the problem is:

In order to prove dual feasibility we need to show that

Fulfills the following conditions:

Proof a:

Assuming

Proof b:

If we try minimize centering problem :

If we substitute (\*\*) into (\*), we get that

Q.E.D.

### Q11

We are asked to prove that

Proof:

### Q12

Solving the centering problem with the Newton method:

Using the gradient of:

And a Hessian of:

### Q13

Phase I problem:

To find a feasible point for the Phase one problem we can choose . Then make sure that choose

To stop the solver from going to very large negative values of and wasting valuable time we add bottom limit to gamma slightly smaller than 0.

For the first problem we get very accurate results:



With a norm difference of: 9.7738e-05

For the second filter design problem with time constraints we get:



The results were also quite accurate: 4.4430e-06