Name:	**ID:**

McMaster University
Final Examination 2021, Term I
SFWRENG/ MECHTRON 3MX3
Dr. M. v. Mohrenschildt

Date: December 15, 2021, 4PM-6PM

Duration: 120 Minutes **(There is no extra time to scan or submit!)**

This examination includes 3 pages and 8 questions. You are responsible for ensuring that your copy of the paper is complete. Bring any discrepancy to the attention of your invigilator.

WATCH YOUR TIME, you need to scan and submit in time !!!

- Make sure you have the time to scan your answers and submit them to Avenue to learn.
- Please keep answers brief and clean.
- Try to allocate your time sensibly, and don't "get stuck" on any one problem.
- By signing and submitting your submission you confirm that you understand what constitutes academic dishonesty and that you solved this exam by yourself.
- For example chatting with others during the exam about the exam is academic dishonesty. And if you chat you will most likely run out of time.

1	10	
2	20	
3	10	
4	15	
5	10	
6	10	
7	10	
8	15	
Mark	100	

‘

Signature

You are required to sign your submission to confirm you understand what constitutes academic dishonesty and that this submission is your own work.

1 Short Questions

(10 points, 5 points each)

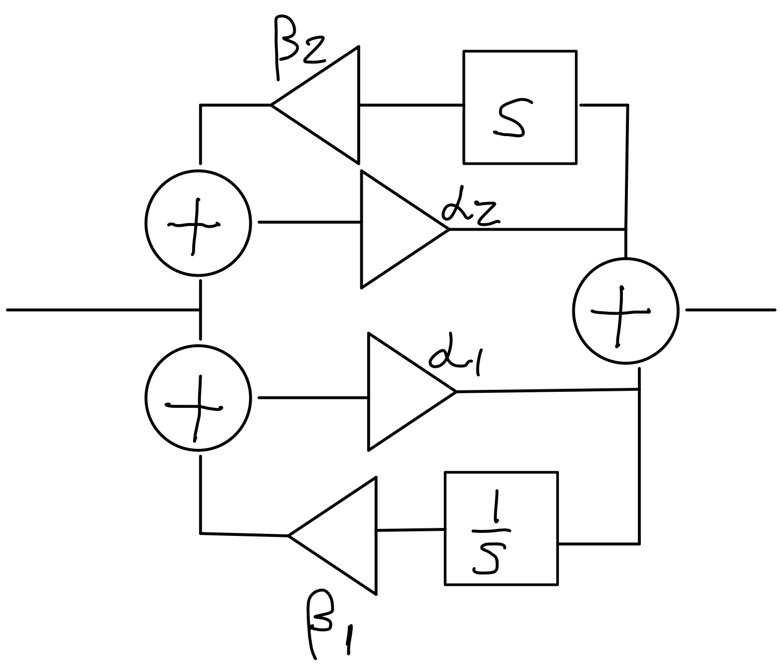
1. **Aliasing** If we convert the pulse $x(t) = \begin{cases} 1 & 0 \leq t \leq 1 \\ 0 & \text{else} \end{cases}$ with an A/D converter it will alias. Explain why?, and make sure you compute the frequency content of this signal in your explanation.
2. **FIR Filter** What are the zeros of $H(\omega)$ for the N-point average filter for $N = 3$.

$$y(n) = \frac{1}{N} \sum_{k=0}^{N-1} x(n-k)$$

   Hint: compute the frequency response and find all zeros, how many are there ?

2 Block Diagrams

(20 points) Derive the transfer function of the system described by the following block diagram:



3 Stability Conditions

(*10 points*) The following questions require small computations, an explanation in English is not accepted as an answer. the answers are 2-3 step computation using the definitions.

1. Show that if $H(\omega)$ exists then the system is BIBO stable.
2. Show, for a FIR system the frequency response is always defined (meaning it is finite).

Continued

4 Z-Domain to State Space

(15 points) Given a system by its transfer function

$$G(z) = \frac{z-1}{1+z}$$

Determine the state space ($[A, B, C, D]$) representation of the system.

5 Step Response

(10 points) Compute the step output, so the output if the input is the step function as defined below, of a system with known impulse response $h(n)$.

$$step(n) = \sum_{k=0}^{\infty} \delta(n-k).$$

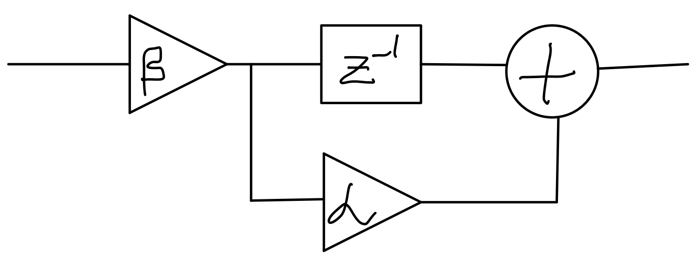
Hint: use linearity

6 Discrete Fourier Transform

(10 points) We know, computing the DFT of a signal using $N = 4$ that $X_0 = 2, X_1 = 4iX_2 = 0$, the other values of X_k are determined by symmetry. What was the original signal ? (give all 4 values, $x(0), \cdots, x(3)$.)

7 Filter Design

(10 points) Select the parameters α and β such that the system given in the following diagram is a low pass filter so $H(\pi) = 0$ and a gain of 1 at DC.



8 Fourier Transform

(15 points)

- *(10 points)* Compute the CTFT of the signal $x(t) = 1 + \cos(t)$. You need to compute each step, the computation is key. There are at least two ways to do this.
- *(5 points)* Explain how your result is related to the Fourier series of the same signal ?

THE END