ECE 5210 Midterm 1

Week of: February 6, 2023

Student's name: ______________________________

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You have 2 hours for 5 problems.

- Show enough (neat) work in the clear spaces on this exam to convince us that you derived, not guessed, your answers.
- Put your final answers in the boxes at the bottom of the page.

You are allowed ONE page of notes (front and back) for this exam. You may use a graphing calculator of your choice. Consulting with any third party is considered cheating.

Problem	Score	Possible Points
1		20
2		20
3		20
4		20
5		20
Total score		100

1 DT systems

Listed below are systems that relate the input $x[n]$ to the output $y[n]$. For each, determine whether the system is (1) linear or nonlinear, (2) time-invariant or time-varying, (3) stable or unstable, (4) causal or noncausal, and (5) memoryless or has memory.

(a) $y[n] = 3x[n] + 1$

(1)	(2)	(3)	(4)	(5)

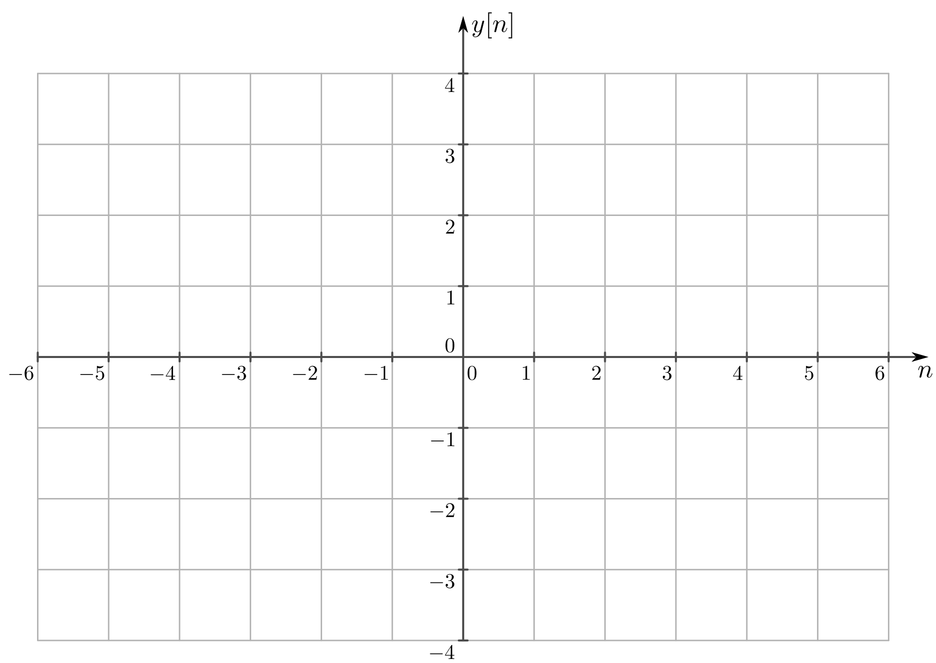
(b) $y[n] = \max\{x[n-1],\, x[n],\, x[n+1]\}$

(1)	(2)	(3)	(4)	(5)

2 Convolution

(a) Sketch the solution for the convolution of $x[n]$ and $h[n]$ where

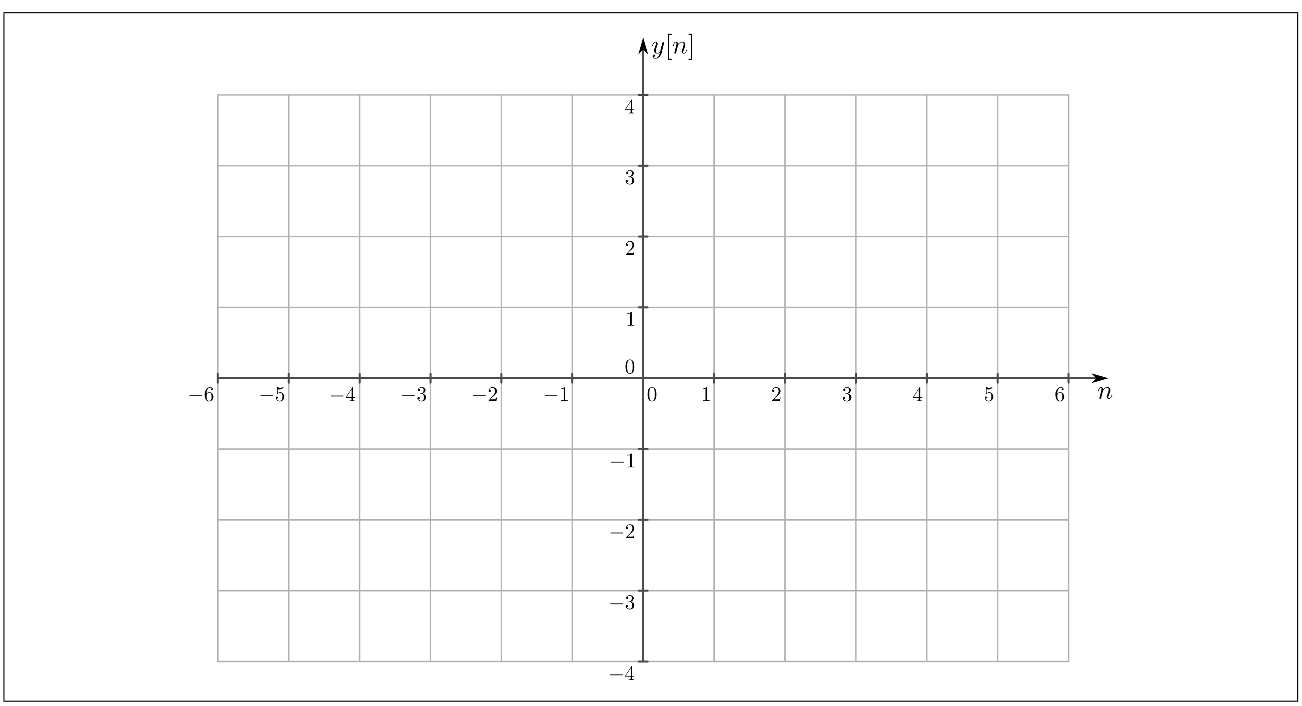
$$x[n] = u[n-1] - u[n-4]$$
$$h[n] = u[n+1].$$



(b) Sketch the solution for the convolution of $x[n]$ and $h[n]$ where

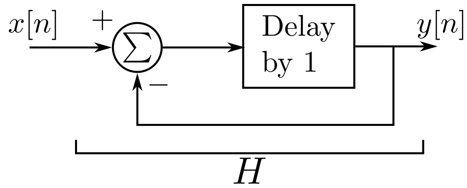
$$x[n] = \sin\left(\frac{\pi n}{2}\right) u[n]$$
$$h[n] = u[n+2].$$

Hint: sketching the signals should give you a bit of intuition on how to handle this problem.



3 z-transform

Consider a system H which is depicted in the figure below.



(a) Determine the transfer function of the system $H(z)$.

$H(z) =$

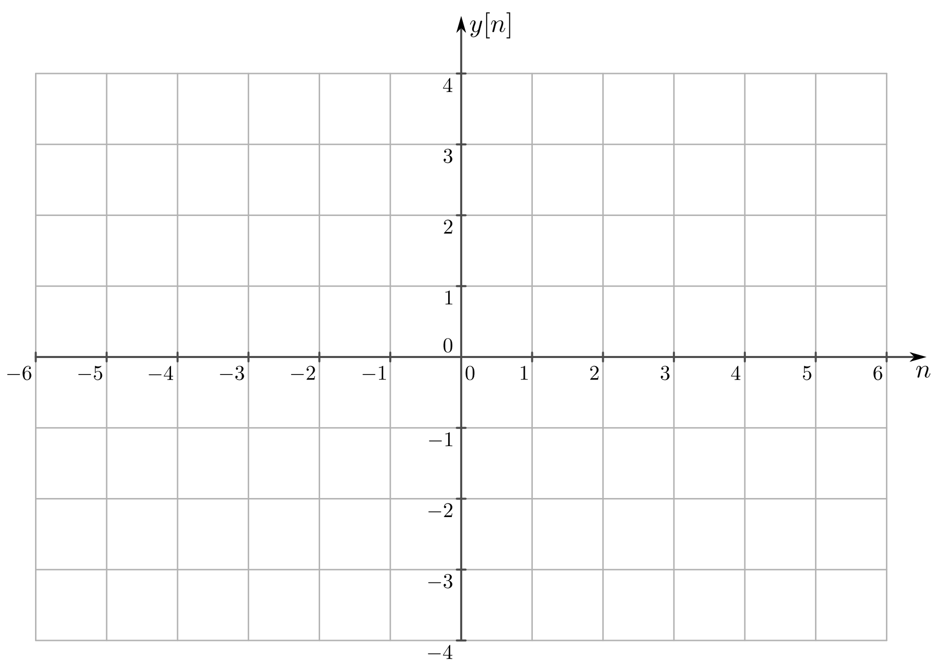
(b) Determine the impulse function of the system $h[n]$.

$h[n] =$

(c) Given some input $x[n] = u[n]$, determine the z-transform of the output $Y(z)$.

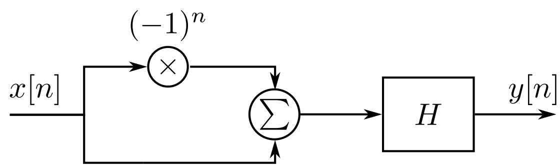
$Y(z) =$

(d) Sketch the time-domain ouput $y[n]$.



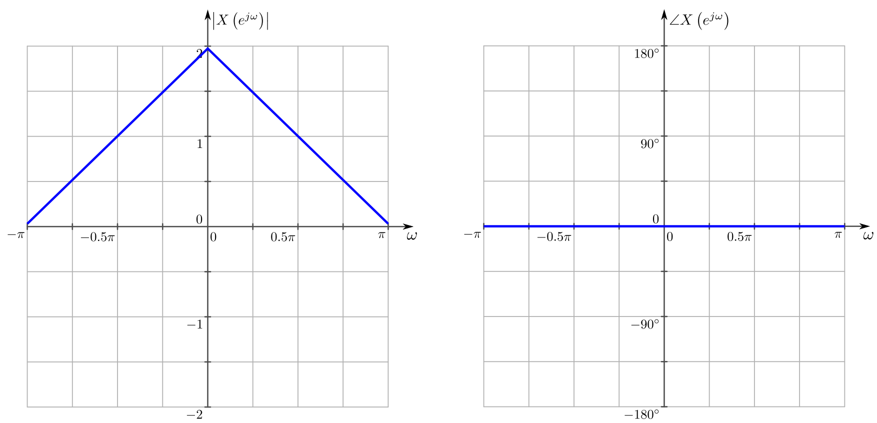
4 DTFT

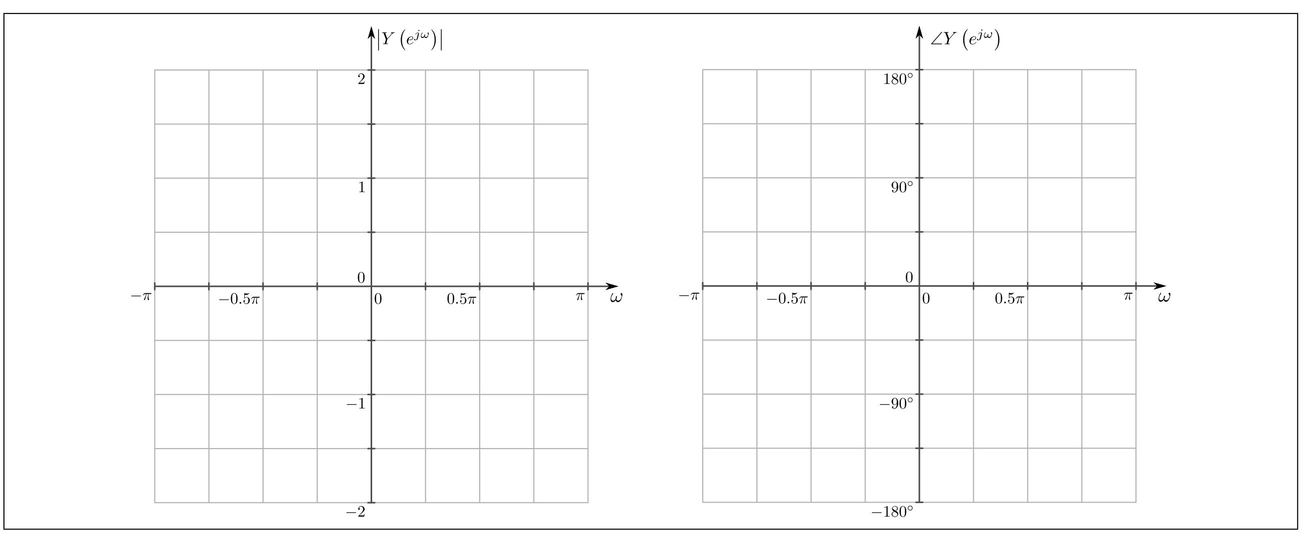
Consider the discrete-time system below where the subsystem H which is an ideal low-pass filter with a



passband gain of 1 and a cutoff frequency of $\omega_c = \pi/4$.

(a) If we have an input $x[n]$ with a DTFT $X\left(e^{j\omega}\right)$ as depicted below, sketch the DTFT of the output $Y\left(e^{j\omega}\right)$.





(b) What is the output $y[n]$ in the time-domain?

$y[n] =$

5 Sampling

(a) If we have a continuous time domain signal

$$x_c(t) = \cos(40\pi t) + \sin(120\pi t)$$

and is sampled with a sampling period T to obtain a discrete-time signal

$$x[n] = \cos\left(\frac{2\pi n}{5}\right) - \sin\left(\frac{4\pi n}{5}\right)$$

what is T?

$T =$

(b) Is your choice for T unique? If not, what is another value of T that will satisfy this C/D conversion?

Circle one:	Yes	No	$T =$

(c) Suppose the $\sin(120\pi t)$ term in your digitized signal. Assume you can only use analog and/or digital low-pass filters, what strategy could you use to remove it? Please describe it in the box below.

(d) If we were to sample $x_c(t)$ with $T = 12.5\,\text{ms}$ it would result in a single sinusoid in the form

$$x[n] = A\cos(\omega n + \phi).$$

What is the amplitude A, the frequency ω, and the phase ϕ?

$A =$	$\omega =$	$\phi =$