

ECE 466 Midterm 1

Name:

PID:

February 21, 2022

- Don't forget to write your name.
- Open textbook.
- Read carefully and write legibly. For the problems with partial credit, show your work.
- For those of you who are remotely solving the exam:
 - You can solve your exam in a-4 sheets or on your tablet.
 - You need to send a scanned pdf or image until 11:45 AM, Tuesday 22nd, to sofuoglu@msu.edu. Otherwise, your exam will not be accepted.
 - Make sure your answers are legible from pdf or scanned image.

1. No partial points for the following.

(a) [15 Points] Check if the following systems fits the classifications on the columns.

System Equation	Linear	Time Invariant	Static	Causal	Stable
$y[n] = x[-n]$					
$y[n] = 2n^2x[n] + nx[n+1]$					
$y[n] = \cos(2\pi x[n])$					

(b) [5 Points] The sequence $x[n] = \cos\left(\frac{\pi}{2}n\right)$ was obtained by sampling an analog signal $x(t) = \cos(\Omega t)$ at a sampling rate of $F_s = 100$ Hz. What are two possible values of Ω ?

(c) [5 Points] What is the ideal sampling frequency of $x(t) = u(t)$?

- (d) [5 Points] The causal sequence $x[n] = \{3, 1\}$ is input to a system with impulse response $h[n]$, producing the zero-state response $y[n] = \{6, -1, 2, 1\}$. Determine $h[n]$.
- (e) The impulse response of a DT (Discrete Time)-LTI system is given by $h[n] = A(0.7)^n u[n]$. Suppose $x[n] = B \cos(0.2\pi n) u[n]$ is input to the system. Which of the following could be the output signal $y[n] = h[n] * x[n]$?
- $K_1(0.7)^n \cos(0.2\pi n + \theta) u[n]$.
 - $K_1(0.14)^n u[n] + K_1 \cos(0.14\pi n \theta) u[n]$.
 - $K_1(0.7)^n u[n] + K_2 \cos(0.2\pi n + \theta) u[n]$.
 - $K_1(0.7)^n u[-n] + K_2 \cos(0.2\pi n + \theta) u[n]$.
2. [30 Points] Consider a causal LTI system described by the difference equation $y[n] = \frac{2}{15}y[n-1] + \frac{1}{15}y[n-2] + x[n]$ with $y[-1] = 1$, $y[-2] = -1$.
- [6] Find the impulse response $h[n]$.
 - [4] Determine if the system is (1) FIR or IIR, and (2) stable.
 - [8] Find the zero state response for $x[n] = u[n]$. (*Decide on particular response's K first.*)
 - [8] Find the zero input response.
 - [4] Find the total response for $x[n] = u[n]$. Identify the steady state and transient responses.

Extra page for Question 2

3. [30 points] A causal LTI system has a system function $H(z) = \frac{1+z^{-1}}{1-\frac{3}{5}z^{-1}+\frac{2}{25}z^{-2}}$.
- (a) [5] Determine the difference equation that this system function describes.
 - (b) [2] What is the gain of the system?
 - (c) [5] Plot the pole-zero map.
 - (d) [5] Determine the region of convergence (ROC).
 - (e) [5] Is the system stable? Why?
 - (f) [8] Find the input signal $x[n]$ that will produce the output $y[n] = 2\left(\frac{2}{5}\right)^n u[n] - \left(\frac{1}{5}\right)^n u[n]$.

Extra page for Question 3