YILDIZ TECHNICAL UNIVERSITY

FACULTY of ELECTRICAL and ELECTRONICS ENGINEERING / DEPARTMENT of BIOMEDICAL ENGINEERING

Name and surname:	**Student number:**			**Signature:**	
Course: BME3161 Biosignal Processing	**Date / Time:** 14.01 2021 / 14:00			**Time:** 110 minutes	
Exam Type:	**Midterm1**	**Midterm2**	**Make-up** for Midterms	**Final** X	**Make-up**
Title Name-Surname: Assist. Prof**.** Dr. İsmail CANTÜRK **(Instructor)**					

1. **(40p)**Consider the LTI system with system function

$$H(z) = \frac{1 + 2z^{-1}}{1 - \frac{5}{4}z^{-1} + \frac{3}{8}z^{-2}}$$

(i) Plot the pole-zero diagram and indicate the region of convergence.

(ii) Determine LCCDE relating to x[n] and y[n].

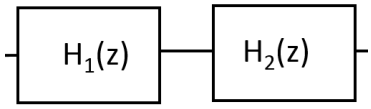
(iii) Draw a direct form 1 implementation of the system.

(iv) Draw a direct form 2 implementation of the system.

(v) Find the number of required memory units to implement direct form 1 and 2.

(vi) Determine the number of additions and multiplications to compute each sample of the output y[n] for direct form 1 and 2.

2. **(30p)**Consider the below system.



$$H_1(z) = \frac{(1 - 0.8e^{-j^{3\pi}/_4}\, z^{-1})(1 - 0.8e^{+j^{3\pi}/_4}\, z^{-1})}{(1 - z^{-1})(2 + z^{-1})}$$

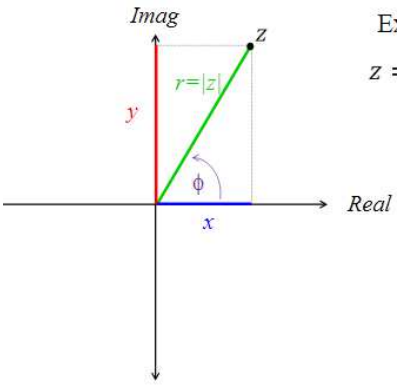
$H_1(z)$ is an IIR filter with a phase response. To maximize the phase response of the system, $H_2(z)$ is cascaded. $H_2(z)$ is known to be an all pass filter.

(i) Plot the pole-zero diagram of $H_1(z)$.

(ii) Locate the poles and zeros of the $H_2(z)$.

(iii) Derive $H_2(z)$.

Hint:



Exponential Form:

$z = re^{i\phi} = |z|e^{i\phi}$

3. **(10p)**Fill in the blanks.

There are two big classes of digital filters. They are …… and ……. . Although …… filters have analog prototypes, ……. filters don't. We use different windowing techniques to limit …….. filters. …… filters have feedback but ……. filters do not. Although …….. filters might be unstable due to location of ……., ……. filters do not have this problem. But ……. filters are more selective in terms of frequency response. If phase response is important, one should use ……. filter.

4. **(20p)**Consider the following discrete time systems.

$(a) y[n] = x[-n]$

$(b) y[n] = x[2n]$

$(b) y[n] = x[n] + x[n-1]$

Comment on below properties of the systems.

(i) Linearity

(ii) Time-invariance

(iii) Causality

(iv) Stability