**EE150 - Signals and Systems, Spring 2020-21**

Homework Set #8

Instructor: Prof. Lin Xu

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**Acknowledgements:**

1) Total Score: **100**.
2) Deadline: **23:59, 12 June, 2021**.
3) Tutorial Time: **19:50, 13 June, 2021, TC101**.
4) Please notice that **no late submission is accepted** for this homework.

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**Problem 1.** (3 × 5 points)

Determine the z-transform for each of the following sequences. Sketch the pole zero plot and indicate the ROC.

1) $2^n u[-n] + (\frac{1}{2})^n u[n-1]$
2) $4^n cos[\frac{\pi}{3}n + \frac{\pi}{4}]u[-n-1]$
3) $n(\frac{1}{2})^{|n|}$

**Problem 2.** (2 × 5 points)

Suppose we are given the following facts about a particular LTI system S with impulse response $h[n]$ and z-transform $H(z)$.

- $h[n]$ is real.
- $h[n]$ is right-sided.
- $\lim_{z \to +\infty} H(z) = 1$.
- $H(z)$ has two zeros.
- $H(z)$ has one of its poles at a non-real location on the circle defined by $|z| = \frac{3}{4}$.

Answer the following two questions with your analysis:

1) Is S causal?
2) Is S stable?

**Problem 3.** (3 × 5 points)

A causal LTI discrete-time system is described by the difference equation

$$y[n] = 0.4y[n-1] + 0.05y[n-2] + 3x[n]$$

where x[n] and y[n] are, respectively, the input and output sequences of the system.

1) Determine the transfer function $H(z)$ of the system.
2) Determine the impulse response $h[n]$ of the system.
3) Determine the step response $s[n]$ of the system.

**Problem 4**. (3×10 points)

Consider the system function corresponding to casual LTI systems:

$$H(Z) = \frac{1}{(1 - z^{-1} + \frac{1}{4}z^{-2})(1 - \frac{2}{3}z^{-1} + \frac{1}{9}z^{-2})}.$$

1) Draw a direct-form block diagram.
2) Draw a block diagram that corresponds to the cascade connection of two second-order block diagrams.
3) Determine whether there exists a block diagram which is the cascade of four first-order block diagrams with the constraint that all the coefficient multipliers must be real. If false, state the reason. If true, draw the diagram.

**Problem 5**. (3×10 points)

Consider a system whose input x[n] and output y[n] are related by

$$y[n-1] + 2y[n] = x[n].$$

1) Determine the zero input response of this system if $y[-1] = 2$.
2) Determine the zero state response of this system to the input $x[n] = (\frac{1}{4})^n u[n]$.
3) Determine the output of the system for $n \geq 0$ when $x[n] = (\frac{1}{4})^n u[n]$ and $y[-1] = 2$.