Name:

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COM-303 - Signal Processing for Communications Midterm Exam

Monday, March 30 2015, 14:15 to 16:15

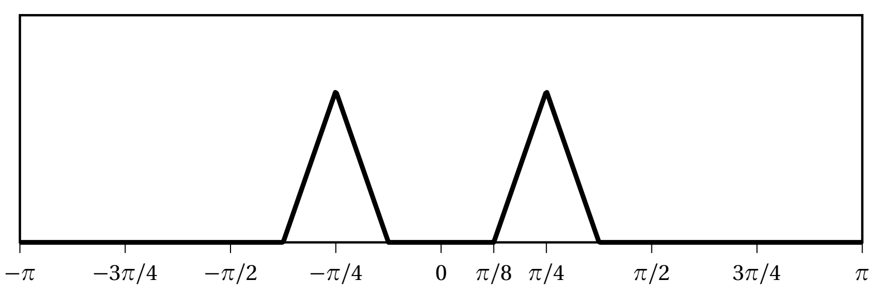
- **Room assignment**: if your last name begins with a letter from 'A' to 'C' inclusive, you should be in room INM200, otherwise you should be in room INF2.
- **Write your name** on the top left corner of **ALL sheets you turn in**, including this one. When you are done, **staple** all your sheets together **with this sheet on top**!
- You can have two A4 sheet of *handwritten* notes (front and back). Please **no photocopies, no books and no electronic devices**. Turn off your phone if you have it with you.
- There are 5 problems with different scores for a total of 100 points.

Exercise 1. (20 points)

Compute the 8 DFT coefficients of the signal $\mathbf{x} = \begin{bmatrix} -1 & -1 & 1 & 1 & -1 & -1 & 1 & 1 \end{bmatrix}^T$.

Exercise 2. (15 points)

Consider the real-valued signal $x[n]$ whose DTFT is sketched (in magnitude) here:



Sketch as accurately as possible the magnitude of the spectrum of the following signals:

(a) $y_1[n] = x[n]\cos(\omega_1 n)$, with $\omega_1 = \pi/4$

(b) $y_2[n] = x[n]\cos(\omega_2 n)$, with $\omega_2 = 11\pi/16$

Exercise 3. (15 points)
Consider a filter whose frequency response is $H(e^{j\omega}) = 1 + \cos(2\omega)$.

(a) is the filter stable?

(b) is the filter causal?

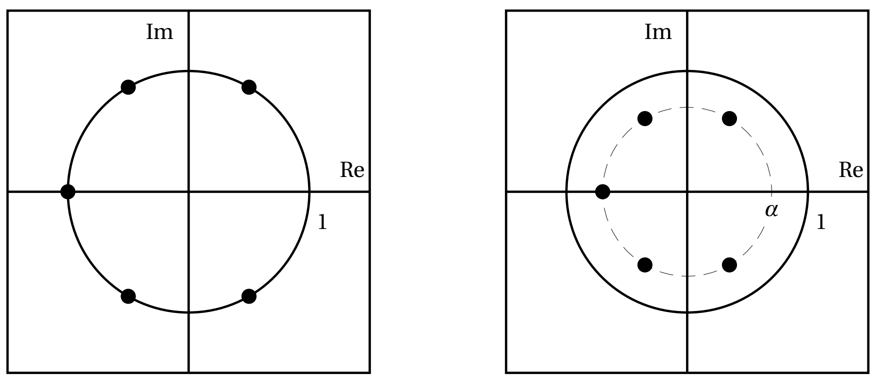
Explain your answers.

Exercise 4. (30 points)
The *left* panel of the figure below shows the pole-zero plot of a moving average filter of length $M = 6$. The right panel of the figure shows a pole-zero plot where the zeros have the same phase as those of a moving average filter but their magnitude is α, with $0 < \alpha < 1$; call $G_M(z)$ the system described by a pole-zero plot as in the right panel, i.e. a system with $M - 1$ equally spaced zeros around a circle of radius α.

(a) is the system stable?

(b) write the expression for $G_M(z)$

(c) find the impulse response of the system.



(a) (b)

Exercise 5. (20 points)
Determine if the system depicted in the diagram below is stable knowing that

$$F(z) = 18 + 2z^{-1} + 6z^{-2} + 2z^{-3}$$
$$G(z) = \frac{1}{2 + 2z^{-1} + 2z^{-3} + z^{-4}}$$