Second Midterm Exam

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Instructors: A. Sheta & S. Aldosari

Date: 19/12/1427

Time: 5:45 - 7:15 pm
Answer All Problems (60 points)

Problem I (20 points)

a- For each of the following signals find:

i. The dc components.
ii- The fundamental and the second harmonic frequencies.
iii- The second harmonic components.

\[ x_1(t) = \left| \cos \frac{t}{2} \right| \]
b- Find the Fourier series representation of the signal

\[ x[n] = 2 + \sin \frac{2\pi n}{3} + 2 \cos 2\pi n \]
Problem II  (20 points)

Consider a CT signal with Fourier transform given by \( X(j\omega) = \frac{1}{(j\omega)^2 + 7(j\omega) + 12} \)

(a) Find \( x(t) \).  

(b) Let \( y(t) = tx(t) + x(t/3) \). Find \( Y(j\omega) \) (the Fourier transform of \( y(t) \)). 

(10 points)

(10 points)
Problem III  (20 points)

The following figure shows a DT linear time invariant system where:

\[ H_1(e^{j\omega}) = \begin{cases} 
1 & |\omega| < \pi/4 \\
0 & \text{otherwise} 
\end{cases} \]

\[ H_2(e^{j\omega}) = \begin{cases} 
1 & \pi/2 < |\omega| < \pi \\
0 & \text{otherwise} 
\end{cases} \]

\[ X(e^{j\omega}) = |\omega|, \quad -\pi < \omega < \pi \]

(a) Find the odd part of \( x[n] \).  
(b) Sketch \( H_1(e^{j\omega}) \), \( H_2(e^{j\omega}) \), and \( X(e^{j\omega}) \).  
(c) Find and sketch \( Z_1(e^{j\omega}) \), \( Z_2(e^{j\omega}) \), \( Z_3(e^{j\omega}) \), and \( Y(e^{j\omega}) \).  

Note: you MUST clearly label all your plots.