ELEC442/6601 DSP: Midterm Exam

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Instructions:

1. ELEC442: Answer questions 1-3. ELEC6601: Answer all questions. Time given 1 hour.
2. Only **two** pages of one crib sheet and a basic calculator are allowed.
3. Return the question paper before you leave the exam room.

Q1 (**33 marks**)

The even part of a real sequence $x[n]$ is defined by

$x_e[n] = \frac{x[n]+x[-n]}{2}$.

Suppose that $x[n]$ is a real finite-length sequence defined such that $x[n] = 0$ for $n < 0$ and $n >= N$. Let $X[k]$ denote the N-point DFT of $x[n]$.

a) Is the $Re(X[k])$ the DFT of $x_e[n]$?
b) What is the inverse DFT of $Re(X[k])$ in term of $x[n]$? (Bonus)

Q2 (**33 marks**)

In the system in the figure below, $X_c(j\Omega)$ and $H(e^{j\omega})$ are as shown. Sketch and label the Fourier transform of $y_c(t)$ for each of the following cases:

a) $1/T_1 = 1/T_2 = 10^4$
b) $1/T_1 = 1/T_2 = 2 \times 10^4$

Q3 (**33 marks**)

For each of the following sequences, determine the z-transform and region of convergence, and sketch the pole-zero plot:

a) $x[n] = n^2 a^n u[n]$
b) $x[n] = e^{n^4}[cos(n\pi/12)]u[n] - e^{n^4}[cos(n\pi/12)]u[n-1]$

Q4 (**33 marks**)

A sequence $x[n]$ is obtained by sampling a continuous-time signal with period T. From this sequence a new signal having the sampling period $T/2$ is derived by using a linear interpolation method described by the equation
$y[n] = x[n/2]$ for n even
$y[n] = 1/2[x[\frac{n-1}{2}] + x[\frac{n+1}{2}]]$ for n odd

(a) Determine the spectrum $Y(e^{j\omega})$ of $y[n]$ in terms of the spectrum $X(e^{j\omega})$ of $x(n)$.
(b) Draw a diagram to implement this interpolation scheme.