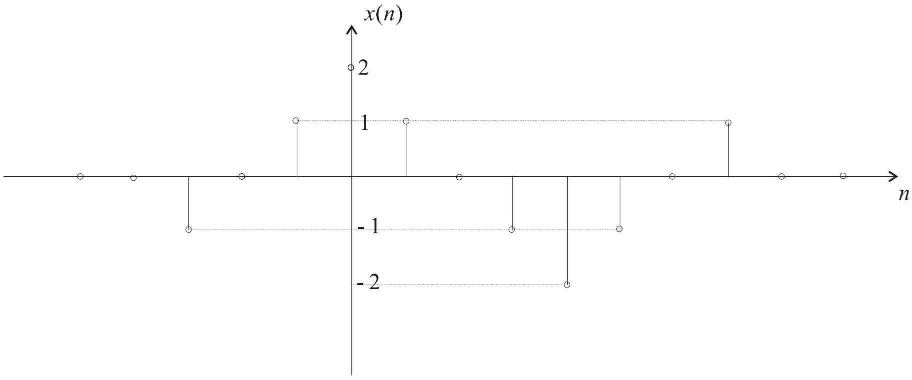
1. (20)
   Let $x(n) \leftrightarrow X(e^{j\Omega})$ by DTFT, where $x(n)$ is given by



   Evaluate the following without explicitly computing $X(e^{j\Omega})$:

   (a) (5) $X(e^{j0})$

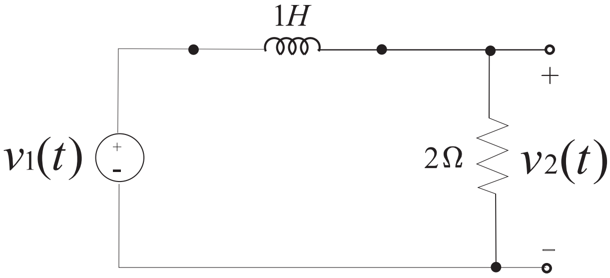
   (b) (5) $\arg\{X(e^{j\Omega})\}$

   (c) (5) $\int_{-\pi}^{\pi} |X(e^{j\Omega})|^2 d\Omega$

   (d) (5) $\int_{-\pi}^{\pi} X(e^{j\Omega}) e^{j3\Omega} d\Omega$

2. (20)
   Assume that $x(t)$ is band limited. In other words, $X(f)$ is assumed zero for $|f| \geq f_h$. We now sample this signal with an ideal sampler with $f_s > 2f_h$. Let $x_s(t)$ be this sampled signal and $X_s(f)$ be the corresponding FT. Then express $X_s(f)$ with f_s and $X(f)$ and justify your answer.

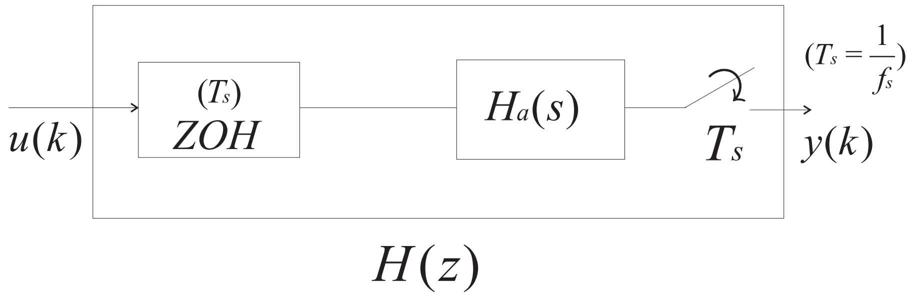
3. (40)



   (a) (5)
   Find $H_a(s) = V_2(s)/V_1(s)$

   (b) (10)
   Using the bilinear z-transform, find $H(z)$ having the same $3dB$ bandwidth as $H_a(s)$. The sampling frequency f_s is 10Hz.

(c) (10)
Plot $|H_a(j\omega)|$ and $|H(e^{j\omega T_s})|$ using the Bode Plot. ($T_s = \frac{1}{f_s}$)



(d) (15)
Using the $H_a(s)$ as given in (a), find $H(z)$ in the above block diagram.
(Hint: use $\mathscr{Z}(\mathscr{L}^{-1}\{(1-e^{-sT_s})P(s)\}|_{t=nT_s}) = (1-z^{-1})\mathscr{Z}(\mathscr{L}^{-1}\{P(s)\}|_{t=nT_s}))$

4. (20)
A nonideal sampling operation obtains $x(n)$ from $x(t)$ as

$$x(n) = \int_{(n-1)T_s}^{nT_s} x(t)dt,$$

(a) (15)
Show that this equation can be written as ideal sampling of a filtered signal $y(t) = x(t) * h(t)$ (i.e., $x(n) = y(nT_s)$), and find $h(t)$.
(Hint: let $y(t) = \int_{t-T_s}^{t} x(t)dt$)

(b) (5)
Express the FT of $x(n)$ in terms of $X(j\omega)$, $H(j\omega)$, and T_s.