PURPOSE: The purpose of this project is to examine the effects of sampling on the frequency response of a system.

Consider the following system:

1. Write a set of state equations with $z = [i \ v]^T$, i.e. determine $\{A, B, C, D\}$. The output is the capacitor voltage.

2. Using Matlab get plots of the magnitude and phase of the transfer function over the frequency range $10 \leq \omega \leq 10000$. Label these plots, PLOT 1 and PLOT 2. Plot magnitude in dB and phase in degrees.

3. Assuming an input $v_g(t) = u(t)$, the unit step function, derive a difference equation that relates the next sampled point to the present sampled point.

4. Take the $Z$-transform of this difference equation to get $Y(z) = Y^*(s)$ and with the $L$-transform of the input $X(s)$ find the transfer function of the system, $H(s) = Y^*(s)/X(s)$.

5. Using a sampling period of $T = 2\pi/5000 = 1.25 \text{ ms}$ (and $z = e^{j\omega T}$), use Matlab to plot the magnitude and phase of the transfer function $T \times H(s)$ over the same frequency range as given in (2). Label the plots, PLOT 3 and PLOT 4.

6. Put the results obtained in (2) and (5) on the same plot. Label the plots, PLOT 5 and PLOT 6.

7. Repeat (3) to (6) above, but now with $v_g(t) = \cos(\omega t)$. From (5) you will get PLOT 7 and PLOT 8 and from (6), PLOT 9 and PLOT 10.

8. Comment on your results. What has been the effect of sampling? Over what frequency range are the effects of sampling evident?