Homework Assignment 05

Question 1  In this question we review material (covered in other courses) related to the transfer function of a linear system.

Part (a) A filter has the transfer function below. Determine the output $y(t)$ if the input is $x(t) = 2 \cos(2\pi 10t)$. (10 points)

$$H(s) = \frac{1,000}{s^2 + 16s + 1,000}$$

Part (b) A normalized second order LPF has poles at $s = 1 \pm j \text{ rad/s}$. There are no transmission zeros and the gain at dc is 4. Determine the transfer function. (5 points)

Part (c) A filter has the transfer function shown—at what frequency will it “ring” in response to a step input? What is the percentage overshoot? Once the transient is over, what is the output in response to a step input? Hint: Use the Laplace Transform’s Final Value Theorem. (20 points)

Question 2  Determine the oscillation frequency for the circuit below. Show your work. (30 points)

Note: This is a relaxation and not a sinusoidal oscillator, so you don’t have to determine the loop gain etc.

Question 3  Consider the astable oscillator implemented with an ideal, inverting Schmitt trigger. The trip voltages are $\pm 2$ V, the output voltage switches between $\pm 5$ V, $R_f = 2K$, and $C_1 = 0.1 \mu F$. Determine the oscillation frequency in Hz. (10 points)

Question 4  For the oscillator shown, the Schmitt trigger has upper trigger voltage $V_{TH} = 3$ V, lower threshold voltage $V_{TL} = 2$ V, and the output voltage is either 5 V or 0 V. The trigger is an inverting trigger and has $R_O = 0$ and $R_{in} \to \infty$. Determine the frequency of oscillation and the duty cycle. (25 points)