Extra Credit

Submission Deadline: April 29, 2017 11:59 PM

Instructions:

i) **Submit on Blackboard before the mentioned deadline. You can actually type your answer, or write on paper and take a clear picture or scan it.**

ii) **No collaboration is allowed for any problems. Any evidence of collaboration will result in an F in the course.**

iii) **Each problem is worth 10 points. The points will be added to your midterm score at the ratio of 10:1. So, it can add as much as 10 points to your mid-term score.**

iv) **Your midterm score will not cut-off at 50, so I recommend everyone to attempt this exercise.**

v) **Late submission will not be accepted.**

1. Consider a low pass signal

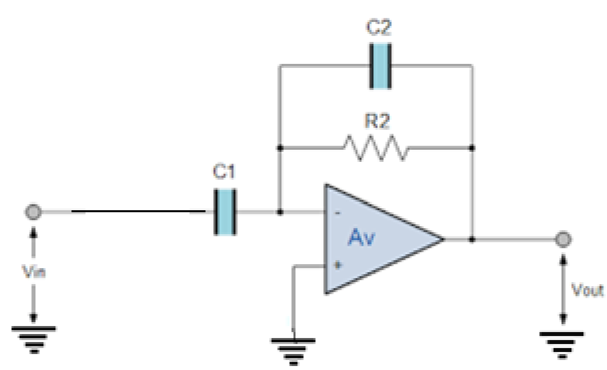
$$x(t) = 10sinc(100t)$$

i) Find the Nyquist rate of the signal.

ii) Plot the sampled signal i.e. the output of the sampler when the $x(t)$ is sampled at

   a. At Nyquist rate
   b. 2 times Nyquist rate
   c. Half of Nyquist rate

2. Derive the frequency response of the following active RC circuit. You have to shows the steps of derivation. Plot the Bode plot for the range $1 < \omega < 100000$.
   Use C1=1 nF, C2=10 μF, R2=47$k\Omega$



3. Find the frequency response of the following discrete time filter. Plot the magnitude response (in dB) and phase response for the range $-2\pi < \Omega < 2\pi$.

$$H(z) = \frac{z - \frac{1}{2}}{\left(z + \frac{3}{4}\right)\left(z + \frac{5}{6}\right)\left(z + \frac{1}{6}\right)}$$

4. A message signal $x(t) = 3\cos(2\pi X1000t) + 2\cos(2\pi * 2000t)$ modulates a carrier signal $c(t) = \cos(2\pi X800000t)$ using DSB-TC modulation. Use $K = 10, m = 0.5$.

   i) Find the DSB-TC modulated signal.
   ii) Plot the frequency response of all message, carrier and DSB-TC signals.

5. A message signal $x(t) = 3sin(1000\pi t)$ is used to frequency modulate a carrier signal $c(t) = \cos(2\pi X100X10^6 t)$. Use $k_f = 2\pi X10^3\ Hz/Volt$
   i) Find time domain as well frequency domain expression of the FM signal.
   ii) What is the transmission bandwidth of this FM signal?

6. Are the systems with the given transfer functions stable, unstable and marginally stable? Why?
   i) $H(s) = \frac{s}{s^2+5s+6}$
   ii) $H(s) = \frac{1}{s^2-2s+2}$

7. Draw the root locus plot for the system with the following loop transfer function. Is the system always stable?

$$T(s) = \frac{K(s-2)}{(s^2+16)(s+3)}$$

8. Find the steady state error of a unity gain feedback system with forward path $H_1(s) = \frac{1}{s^2+5s+5}$ for unit step input. What is the response signal? Plot response signal and unit step signal on the same graph.

9. Consider a system with transfer function $H(s) = \frac{5}{(s^2+4)}$. Find the response of the system for the input $x(t) = \cos(6\pi t)$.

10. Draw the cascade and parallel realization of the following system.
    $H(s) = \frac{s}{(s^2+25)(s+6)}$