EE103 Final Examination
Dec. 12, 2017 4:00-7:00 p.m.

Name______________________   ID_________________________

i. You are allowed to use 2 pages of formulas and tables, but not any concept descriptions or derivations.

ii. Please fill the score blanks below:
    Qz1_________ Qz2_________ Qz3_________ Qz4_________
    Qz5_________ Qz6_________ Qz7_________ Qz8_________
    Delete two lowest scores and provide the average of 6 quizzes in 2 decimal points
    Average= ___________

    Midterm Exam Score (modified)= ___________

iii. The final course grade will be based on the following weights

    Quiz Average 20%
    Midterm Exam 30%
    Final Exam 50%

Final Exam provides 6 Problems

[1] 20 points __________
[2] 15 points __________
[3] 20 points __________
[4] 20 points __________
[5] 20 points __________
[6] 5 points __________

Total 100 points __________
[1] (20 points) Given a function \( x(t) = (2(t + 1) u(t+1) - 2t u(t) - 2 u(t-2) \)

a new function \( x_1(t) \) is defined as \( x_1(t) = 2 x_{\text{even}}(t) + x_{\text{odd}}(t) \).

Plot \( x_{\text{even}}(t) \), \( x_{\text{odd}}(t) \) and \( x_1(t) \) on the graph below.

Express \( x_1(t) \) mathematically

\[ \boxed{ \text{Expression for } x_1(t) } \]
[2] (15 points) A linear time-invariant (LTI) system is described represented below.

\[ x(t) = \delta(t) \]

\[ y(t) = h(t) \]

For \( h(t) = e^{-3t} u(t) \) and \( x(t) = \text{rect}(t/2) \), find \( y(t) \) by using \( y(t) = x(t) * h(t) = h(t) * x(t) \).
[3] (30 points) A windowed function is plotted below.

(a) (10 points) **Write down a mathematical description of** \( x(t) \) **by using the cosine and rectangular functions.**

\[
x(t) = ( \text{cosine function} ) x ( \text{rectangular function} )
\]

Let \( x_1(t) = x(t) \times \sum_{k=-\infty}^{\infty} \delta(t - k3\pi) \)

(b) (20 points) **Find Fourier transform of** \( x_1(t) \).

Step 1 (10pts) First find \( X(\omega) \)

Step 2 (10pts) Find \( X_1(\omega) \)
[4] (20 points) Let us consider the following OP amp circuit.

Let \( C_1 = 2 \, C_2 = 1 \, \mu F \), all resistance values are \( 1 \, M\Omega \)

(a) (15 points) Find \( H(s) = \frac{V_o(s)}{V_i(s)} \)
(b) (5 points) **Find** $h(t)$ **by taking inverse Laplace transform of** $H(s)$. 
[5]. (20 points) The following figure show a Bode plot of a band-pass filter.

At $\omega = \omega_1$, the gain in dB is 10 dB.

(a). (10 points) Find the corresponding $H(j\omega)$ with identification of all zero and pole (angular) frequencies. Hint: $H(j\omega) = \frac{K (1 + j \omega/\omega_z)}{[(1 + j \omega/\omega_{p1})(1 + j \omega/\omega_{p2})]}$ and $\omega_1$ can be found from $H(j\omega)$

(b). (5 points) Find $H(s)$ by replacing $j\omega$ by $s$ and simplifying the terms such that $H(s) = M \frac{N(s)}{D(s)}$, $N(s)$ and $D(s)$ are polynomial functions of $s$. 
(c) (5 points) **Find output** \( y(t) \) for \( x(t) = 10 \cos (100\sqrt{10} t + \Theta_1) + 5 \cos (10000 t + \Theta_2) \).

Hint: \( y(t) = A_1 \cos (100\sqrt{10} t + \Theta y_1) + A_2 \cos (10000 t + \Theta y_2) \)

Find \( A_1, A_2 \) from the gain information in the Bode plot. For simplicity neglect \( \Theta y_1,2 \).

Also, use an approximation as \( I_1 + j K I = K \) for \( K > 3 \).
[6] (5 points) Describe **most significant concepts** you have learned from EE103 in the Fall 2017 quarter.