1. Given the following circuit with $R_1 = 1$, $R_2 = 3$, $R_3 = 4$, $R_4 = 12$, $R_5 = 2$, $L = \frac{1}{4}$, $C = \frac{1}{2}$, and assuming an ideal op-amp,

   (a) Derive the transfer function $H(s)$.
   (b) Using the two-sided Laplace determine the output in the time domain due to an input

   \[ x(t) = 2e^t u(-t) + (1 + \cos(t))u(t) \]

2. For each of the periodic signals below, determine their Fourier Series using the exponential form

   (a) 
   \[ x(t) \]

   (b) 
   \[ x(t) \]

   (c) 
   \[ x(t) \]
3. Obtain the exponential form of the Fourier series expansions for each of the signals below without using integration, but applying trigonometric identities and Euler’s formula.

(a) $\cos(2\pi t)$
(b) $\sin(2\pi t)$
(c) $\cos(2\pi t) + \sin(4\pi t + \pi/4)$
(d) $\sin(10\pi t) \cos(5\pi t)$
(e) $\cos^2(20\pi t) \sin(10\pi t)$

4. Given the two periodic signals below

(a) Determine the spectrum for the two signals.
(b) Using Matlab or Mathematica plot the spectrum for the two signals on the same plot for frequencies below $\pm 3$ Hz.
(c) How would these signals be altered an ideal lowpass filter with a cutoff of 1.5 Hz? Justify your reasoning.
(d) Using Matlab or Mathematica plot the expected response in the time domain to the lowpass filter.
5. Suppose the input to the following circuit, assuming an ideal diode, $R_2 = 1$, $R_3 = 1$, $R_4 = 2$, $R_5 = 3$, $C = \frac{1}{3}$, and the input is $x(t) = \cos(t)$. Derive an expression for the output of the circuit as an exponential Fourier series.

(Hint: derive a transfer function between the input to the op-amp and the output, and write the voltage at the inverting input of the op-amp as a Fourier series.)

6. Given the periodic signals from Problem 4, using Matlab or Mathematica, plot the mean-square error between the Fourier series representation and the original signal as a function of the number of terms used in the expansion. How many terms are needed to get a mean-square error below 1%?