**Full Name:** ______________________________ **Lab Section:** __________

**ECE 3500 (Fall 2015) – Class #10 Examples** **Date:** **Sept. 24 2015**

**Question #1:**

(a) Compute the Fourier coefficients (for the complex exponential form of the Fourier Series) for $x(t) = 2\cos(2\pi t)$.

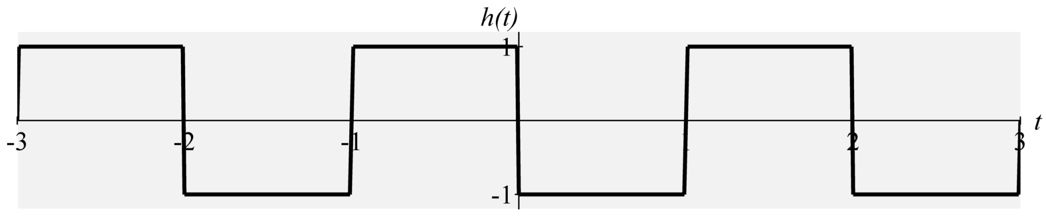
(b) Compute the complex Fourier coefficients (for the complex exponential form of the Fourier Series) for $x(t) = 3\sin(3\pi t) + 1$.

(c) Compute the complex Fourier coefficients (for the complex exponential form of the Fourier Series) for $x(t) = \cos(2\pi t) + \sin(3\pi t)$.

(d) Compute the complex Fourier coefficients (for the complex exponential form of the Fourier Series) for $x(t) = \cos(2\pi t) + 2\sin(3\pi t) + 3\cos((\pi/2)t)$.

**Question #2:**

(a) Compute the complex Fourier coefficients (for the complex exponential form of the Fourier Series) for the signal $x(t)$ below. Assume the pattern continues for $-\infty < t < \infty$.



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**ECE 3500 (Fall 2015) – Class #10 Examples** **Date:** **Sept. 24 2015**

**Question #1:**

(a) Compute the Fourier coefficients (for the complex exponential form of the Fourier Series) for $x(t) = 2\cos(2\pi t)$.

**Solution:** $c_1 = 1$, $c_{-1} = 1$, and all other coefficients are $0$

(b) Compute the complex Fourier coefficients (for the complex exponential form of the Fourier Series) for $x(t) = 3\sin(3\pi t) + 1$.

**Solution:** $c_0 = 1$, $c_1 = \frac{3}{2j} = \frac{-3j}{2}$, $c_{-1} = -\frac{3}{2j} = \frac{3j}{2}$, and all other coefficients are $0$

(c) Compute the complex Fourier coefficients (for the complex exponential form of the Fourier Series) for $x(t) = \cos(2\pi t) + \sin(3\pi t)$.

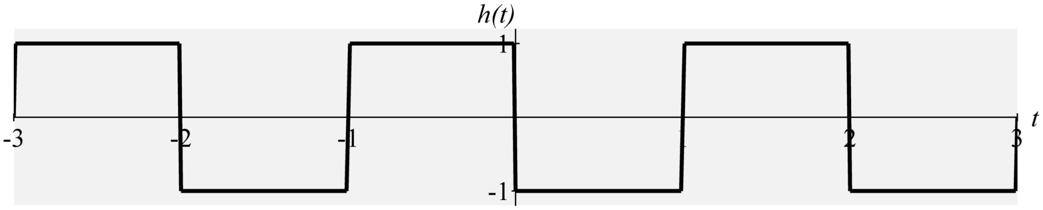
**Solution:** The fundamental angular frequency for this periodic signal is $\omega_0 = \pi$.
$c_2 = \frac{1}{2}$, $c_{-2} = \frac{1}{2}$, $c_3 = \frac{1}{2j} = \frac{-j}{2}$, $c_{-3} = -\frac{1}{2j} = \frac{j}{2}$, and all other coefficients are $0$

(d) Compute the complex Fourier coefficients (for the complex exponential form of the Fourier Series) for $x(t) = \cos(2\pi t) + 2\sin(3\pi t) + 3\cos((\pi/2)t)$.

**Solution:** The fundamental angular frequency for this periodic signal is $\omega_0 = \pi/2$.
$c_1 = \frac{3}{2}$, $c_{-1} = \frac{3}{2}$, $c_4 = \frac{1}{2}$, $c_{-4} = \frac{1}{2}$, $c_6 = \frac{1}{j} = -j$, $c_{-6} = -\frac{1}{j} = j$, and all other coefficients are $0$

**Question #2:**

(a) Compute the complex Fourier coefficients (for the complex exponential form of the Fourier Series) for the signal $x(t)$ below. Assume the pattern continues for $-\infty < t < \infty$.




**Solution:** The fundamental period of this is $T_0 = 2$. Therefore, the angular frequency for this periodic signal is $\omega_0 = \pi$.

$$\begin{aligned}
c_0 &= \frac{1}{T_0}\int_{T_0} x(t)dt = 0 \\
c_k &= \frac{1}{T_0}\int_{T_0} x(t)e^{-jk\pi t}dt \\
&= \frac{1}{2}\int_{-1}^{0} e^{-jk\pi t}dt - \int_{0}^{1} e^{-jk\pi t}dt \\
&= \frac{1}{2}\left(\frac{1}{-jk\pi}e^{-jk\pi t}\bigg|_{-1}^{0} - \frac{1}{-jk\pi}e^{-jk\pi t}\bigg|_{0}^{1}\right) \\
&= \frac{1}{-j2k\pi} - \frac{1}{-j2k\pi}e^{jk\pi} - \frac{1}{-j2k\pi}e^{-jk\pi t} + \frac{1}{-j2k\pi} \\
&= \frac{1}{j2k\pi}e^{jk\pi} + \frac{1}{j2k\pi}e^{-jk\pi t} - \frac{1}{jk\pi} \\
c_{odd} &= \frac{1}{j2k\pi}e^{jk\pi} + \frac{1}{j2k\pi}e^{-jk\pi t} - \frac{2}{jk\pi} \\
&= \frac{1}{j2k\pi}(-1) + \frac{1}{j2k\pi}(-1) - \frac{1}{jk\pi} \\
&= \frac{-2}{jk\pi} \\
c_{even} &= \frac{1}{j2k\pi}e^{jk\pi} + \frac{1}{j2k\pi}e^{-jk\pi t} - \frac{1}{jk\pi} \\
&= \frac{1}{j2k\pi}(1) + \frac{1}{j2k\pi}(1) - \frac{1}{jk\pi} \\
&= 0
\end{aligned}$$

Therefore, $c_k = \frac{-2}{jk\pi} = \frac{2j}{k\pi}$ when $k$ is odd. All other coefficients are $0$.