EEE 5502 HW #06 Hudanyun Sheng

Question #1

I spent 8 hours

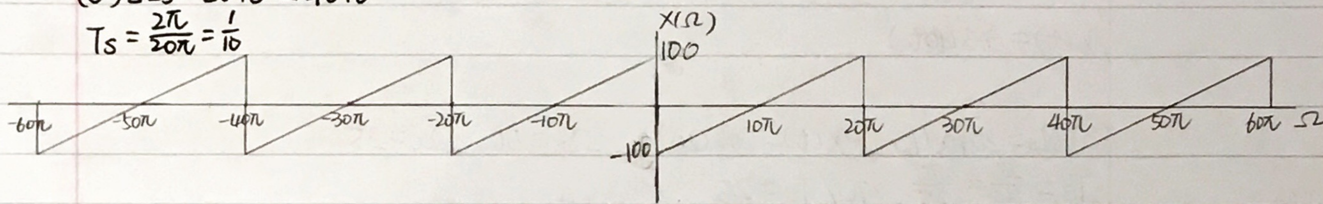
Question #2

(a) $\Omega_N = 2(20\pi) = 40\pi$

(b) $\Omega_N = 2(20\pi)(4) = 160\pi$

(C) $\Omega_s = 20\pi < 40\pi$

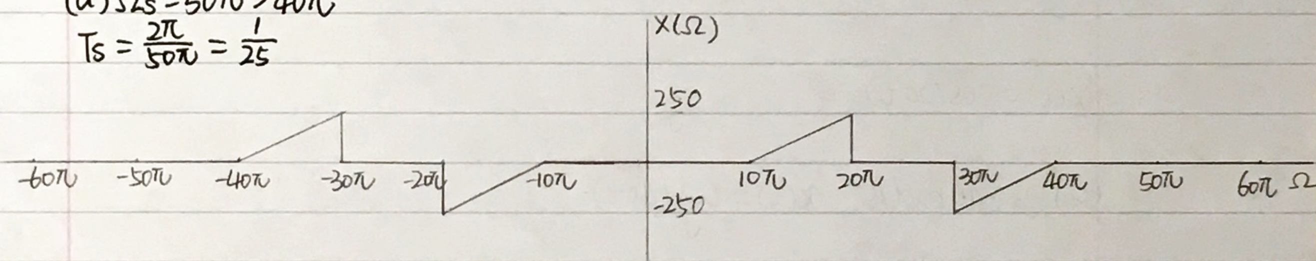
$T_s = \frac{2\pi}{20\pi} = \frac{1}{10}$



Yes we experience aliasing.

(d) $\Omega_s = 50\pi > 40\pi$

$T_s = \frac{2\pi}{50\pi} = \frac{1}{25}$

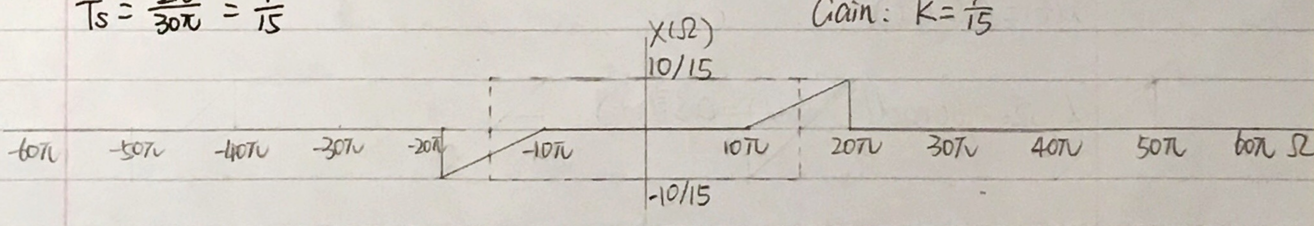


No we don't experience aliasing.

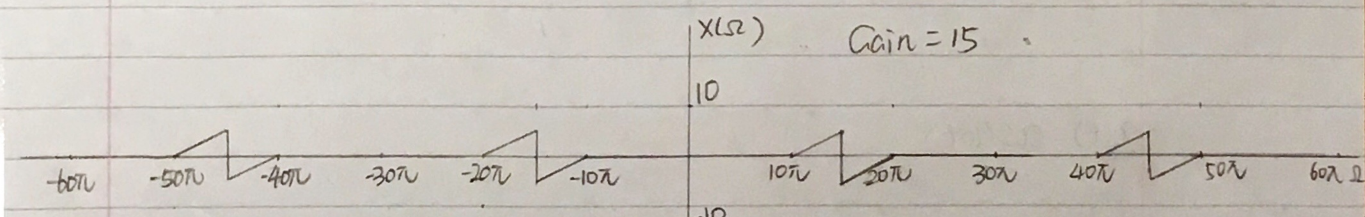
(e) $\Omega_s = 30\pi < 40\pi$, $\Omega_c = 15\pi$

$T_s = \frac{2\pi}{30\pi} = \frac{1}{15}$

Gain: $K = \frac{1}{15}$



Gain = 15



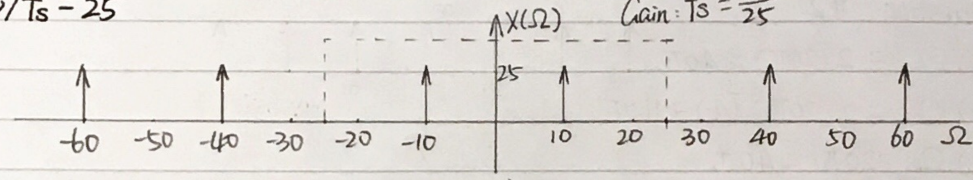
Question #3

(a) $\Omega_0 = 10\ rad/s$, $x(t) = \cos(10t)$. $\Omega_s = 50$, $\Omega_c = 25$

$T_s = \frac{2\pi}{\Omega_s} = \frac{2\pi}{50} = \frac{\pi}{25}$

$\pi / T_s = 25$

Gain: $T_s = \frac{\pi}{25}$

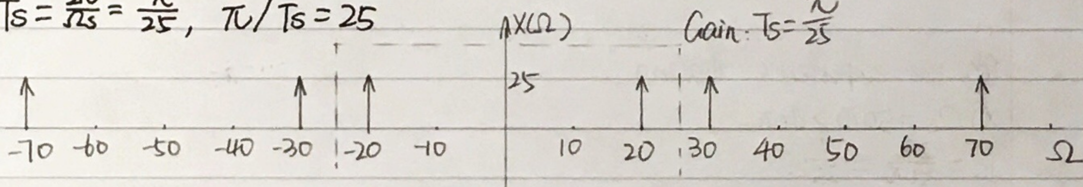


$x(t) = \cos(10t)$

(b) $\Omega_0 = 20\ rad/s$, $x(t) = \cos(20t)$. $\Omega_s = 50$, $\Omega_c = 25$

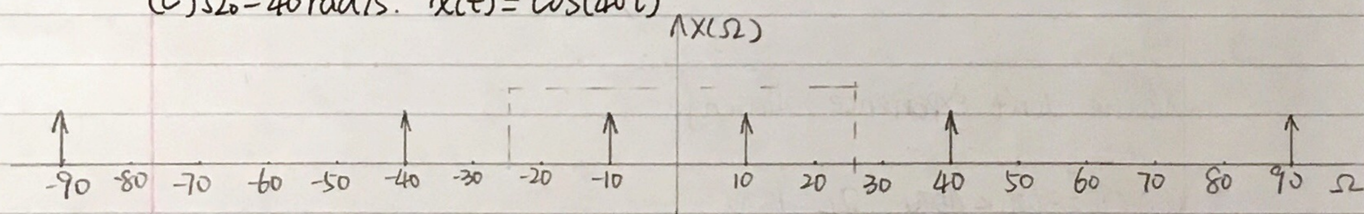
$T_s = \frac{2\pi}{\Omega_s} = \frac{\pi}{25}$, $\pi / T_s = 25$

Gain: $T_s = \frac{\pi}{25}$



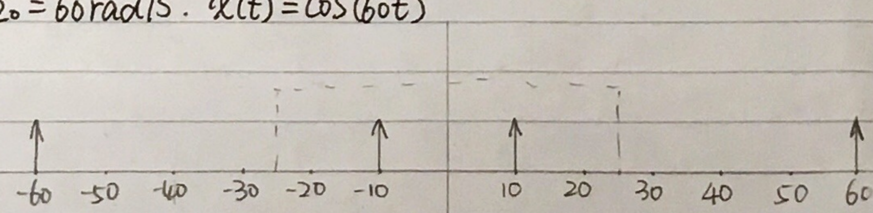
$x(t) = \cos(20t)$

(c) $\Omega_0 = 40\ rad/s$. $x(t) = \cos(40t)$



$x(t) = \cos(10t)$

(d) $\Omega_0 = 60\ rad/s$. $x(t) = \cos(60t)$



$x(t) = \cos(10t)$

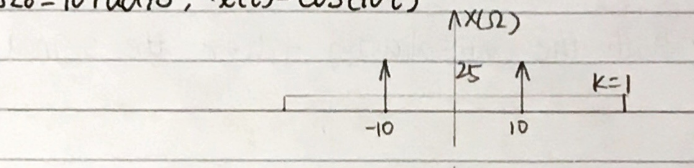
Question #4

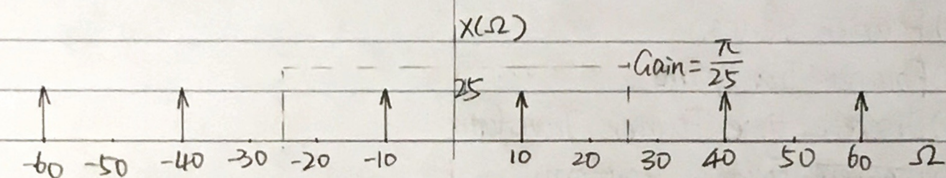
$\Omega_s = 50$ rad/s, ~~$\Omega_c = 25$ rad/s, $K=1$~~

Before: low-pass anti-aliasing filter: ~~Ω_s~~ $\Omega_c = 25$ rad/s, $K=1$

After: $\Omega_c = 25$ rad/s, $T_s = \frac{2\pi}{50} = \frac{\pi}{25} = K$

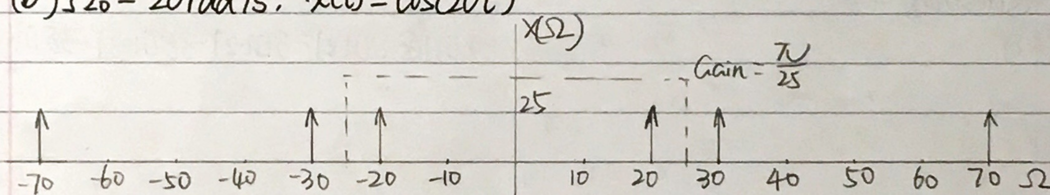
(a) $\Omega_0 = 10$ rad/s, $x(t) = \cos(10t)$





$x(t) = \cos(10t)$

(b) $\Omega_0 = 20$ rad/s, $x(t) = \cos(20t)$



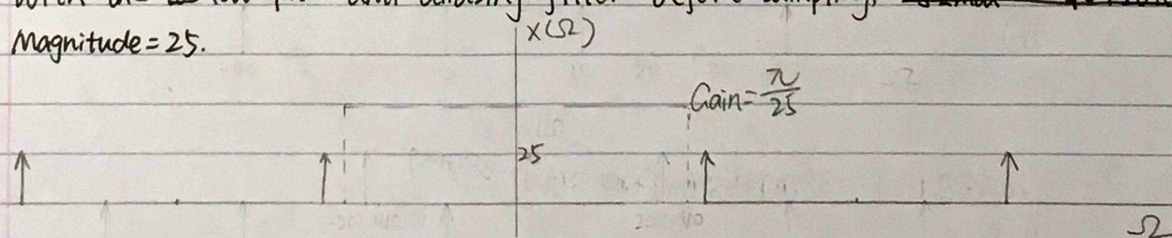
$x(t) = \cos(20t)$

(c) $\Omega_0 = 40$ rad/s, $x(t) = \cos(40t)$

the signal is gone

With the ~~tos~~ low-pass anti-aliasing filter before sampling, ~~$\Omega_{max} = -40+20\pi$~~

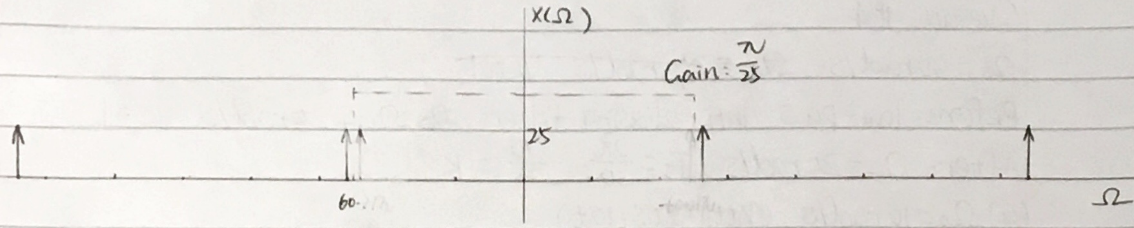
Magnitude = 25.



~~$x(t) = \cos(40t)$~~

(d) $\Omega_0 = 60$ rad/s, $x(t) = \cos(60t)$

With the low-pass anti-aliasing filter before sampling, $\Omega_{max} = -60+27\pi$. Magnitude $=25$.



~~x(t)=cos(60t)~~ With the anti-aliasing filter, the signal is gone

Question # 5

(a) Fourier Series

(b) Fourier Transform

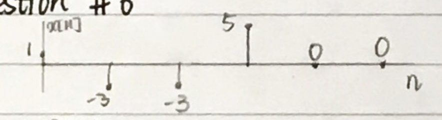
(c) Discrete time Fourier Transform

(d) ~~Discrete~~ Fourier Transform

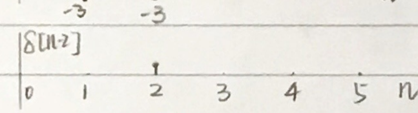
(e) Discrete Fourier Series

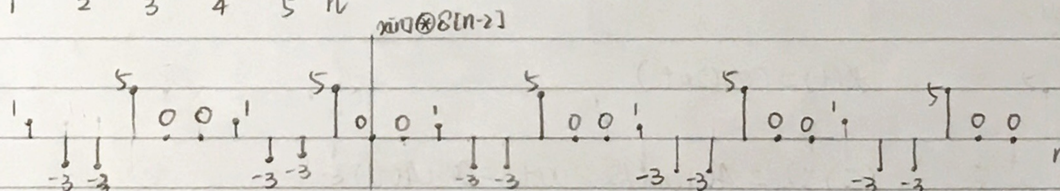
Question #6

(a)

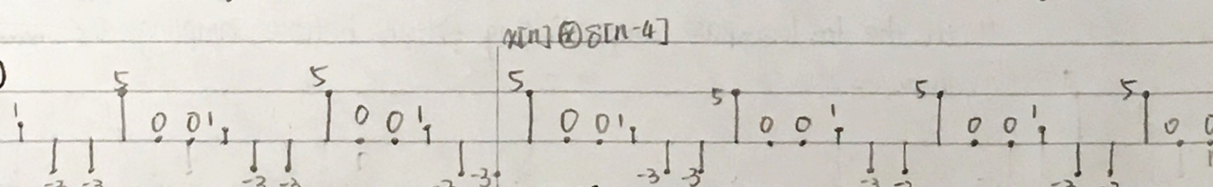


$x[n] \circledast \delta[n-2] = \delta[n-2] - 3\delta[n-3] - 3\delta[n-4] + 5\delta[n-5]$.



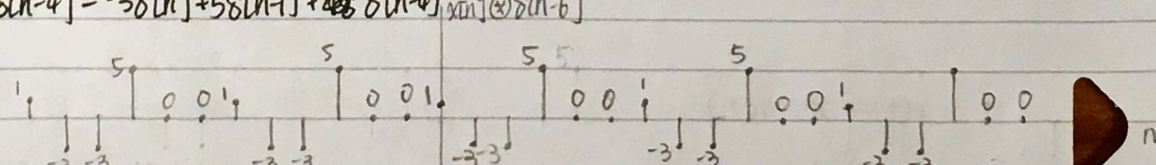


(b)



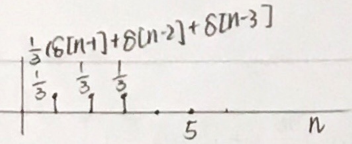
$x[n] \circledast \delta[n-4] = -3\delta[n] + 5\delta[n-1] + \delta[n-4] - 3\delta[n-5]$

(c)



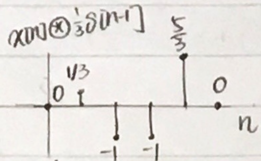
$x[n] \circledast \delta[n-6] = \delta[n] - 3\delta[n-1] - 3\delta[n-2] + 5\delta[n-3]$

(d)

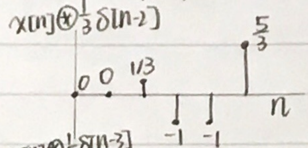


Within one period:

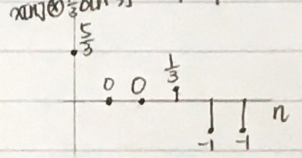
$x[n] \circledast \frac{1}{3}\delta[n-1]$



$x[n] \circledast \frac{1}{3}\delta[n-2]$

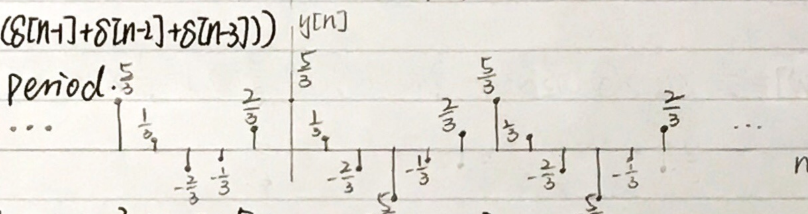


$x[n] \circledast \frac{1}{3}\delta[n-3]$



$y[n] = x[n] \circledast (\frac{1}{3}(\delta[n-1]+\delta[n-2]+\delta[n-3]))$

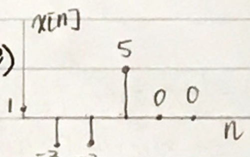
in one period.

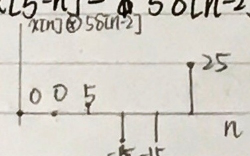


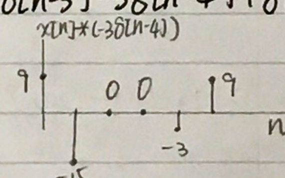
$y[n] = \frac{5}{3}\delta[n] + \frac{1}{3}\delta[n-1] - \frac{2}{3}\delta[n-2] - \frac{5}{3}\delta[n-3] - \frac{1}{3}\delta[n-4] + \frac{2}{3}\delta[n-5]$

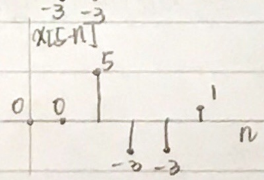
$x[5-n] = 5\delta[n-2] - 3\delta[n-3] - 3\delta[n-4] + \delta[n-5]$

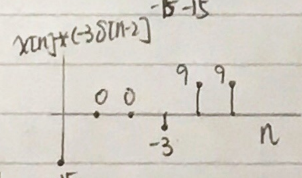
(e)

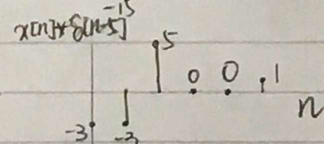


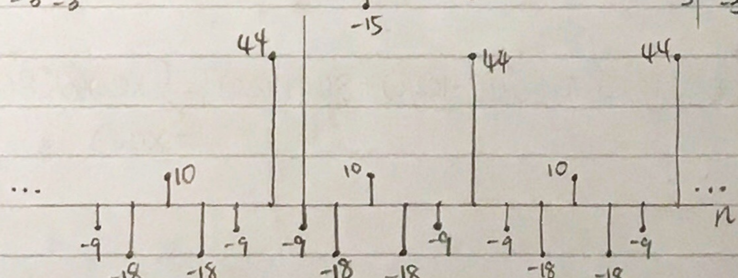












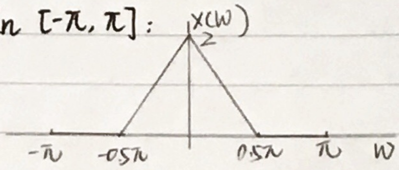
$x[n] \circledast x[5-n] = -9\delta[n] - 18\delta[n-1] + 10\delta[n-2] - 18\delta[n-3] - 9\delta[n-4] + 44\delta[n-5]$

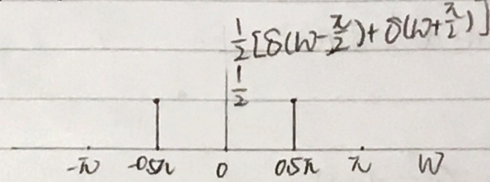
Question #7

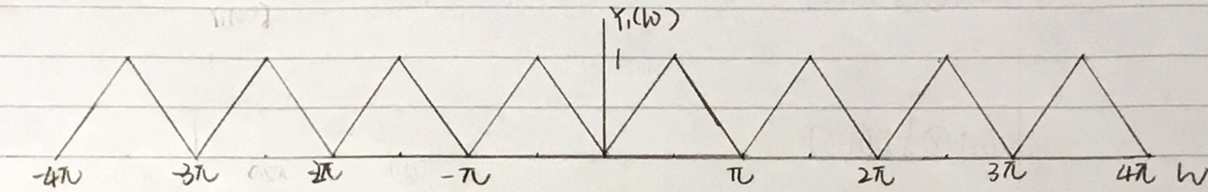
(a) $Y_1(\omega) = \frac{1}{2\pi} X(\omega) \circledast \pi[\delta(\omega - \frac{\pi}{2}) + \delta(\omega + \frac{\pi}{2})]$

$= \frac{1}{2} X(\omega) \circledast [\delta(\omega - \frac{\pi}{2}) + \delta(\omega + \frac{\pi}{2})]$

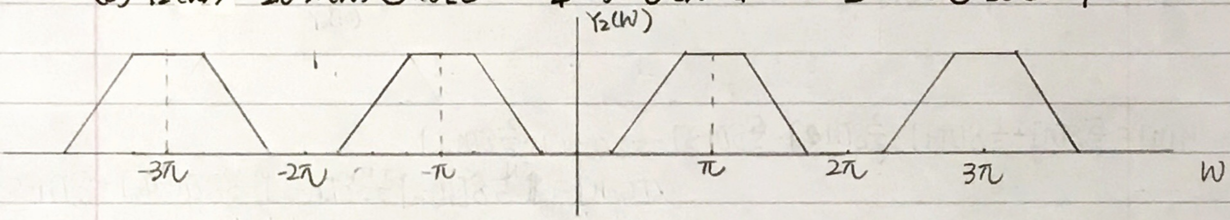
In $[-\pi, \pi]$:





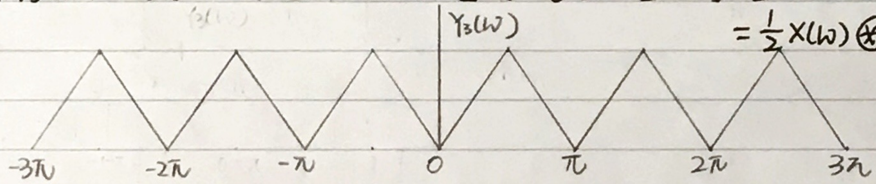


(b) $Y_2(\omega) = \frac{1}{2\pi} X(\omega) \circledast \pi[\delta(\omega - \frac{3}{4}\pi) + \delta(\omega + \frac{3}{4}\pi)] = \frac{1}{2} X(\omega) \circledast [\delta(\omega - \frac{3}{4}\pi) + \delta(\omega + \frac{3}{4}\pi)]$



(c) $Y_3(\omega) = \frac{1}{2\pi} X(\omega) \circledast \pi[\delta(\omega - \frac{3}{2}\pi) + \delta(\omega + \frac{3}{2}\pi)] = \frac{1}{2} X(\omega) \circledast [\delta(\omega - \frac{3}{2}\pi) + \delta(\omega + \frac{3}{2}\pi)]$

$= \frac{1}{2} X(\omega) \circledast [\delta(\omega + \frac{\pi}{2}) + \delta(\omega - \frac{\pi}{2})]$



(d) $Y_4(\omega) = \frac{1}{2\pi} X(\omega) \circledast \pi[\delta(\omega - 102\pi) + \delta(\omega + 102\pi)] = \frac{1}{2} X(\omega) \circledast [\delta(\omega) + \delta(\omega)] = X(\omega) * \delta(\omega)$

$= X(\omega)$