

Question #1

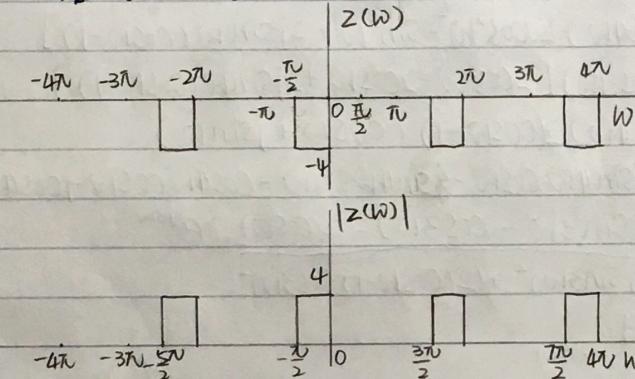
I spent 3 hours.

Question #2

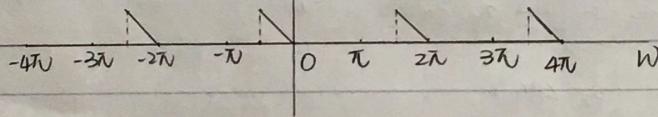
$$Z(\omega) = \sum_{k=-\infty}^{\infty} U(\omega - \frac{\pi}{2} - 2\pi k) - U(\omega + \frac{\pi}{2} - 2\pi k)$$

$$= 4 \sum_{k=0}^{\infty} [U(\omega - (\frac{\pi}{2} + 2\pi k)) - U(\omega + (\frac{\pi}{2} - 2\pi k))]$$

(a)



$$(b) Z(\omega) = |Z(\omega)| e^{j \angle Z(\omega)}$$



$$Z(\omega) = 0$$

(C) $Z(\omega)$ is a low pass filter.

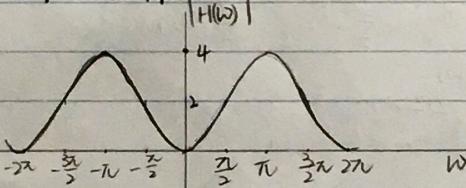
Question #3

$$(a) H(\omega) = -e^{-j\omega} + 2e^{-3j\omega} - e^{-4j\omega}$$

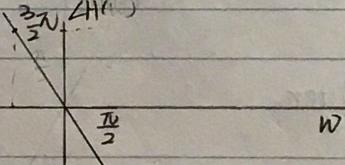
$$\begin{aligned}(b) H(\omega) &= -\cos(2\omega) + j\sin(2\omega) + 2\cos(3\omega) - 2j\sin(3\omega) - \cos(4\omega) + j\sin(4\omega) \\ &= -[\cos(2\omega) + 2\cos(3\omega) - \cos(4\omega)] + j[\sin(2\omega) - 2\sin(3\omega) + \sin(4\omega)] \\ H(\omega) &= -e^{-4j\omega} (e^{2j\omega} - 2e^{j\omega} + 1) = -e^{-4j\omega} (e^{j\omega} - 1)^2 \\ &= (j\sin 4\omega - \cos 4\omega) [\cos \omega + j\sin \omega - 1]^2 \\ &= (j\sin 4\omega - \cos 4\omega) [(\cos \omega - 1) - \sin^2 \omega + 2j\sin \omega (\cos \omega - 1)] \\ &= (j\sin 4\omega - \cos 4\omega) [2\cos^2 \omega - 2\cos \omega + 2j\sin \omega (\cos \omega - 1)] \\ &= (j\sin 4\omega - \cos 4\omega) 2(\cos \omega - 1) (\cos \omega + j\sin \omega) \\ &= 2(\cos \omega - 1) [j\sin 4\omega \cos \omega - \sin 4\omega \sin \omega - \cos 4\omega \cos \omega - j\cos 4\omega \sin \omega] \\ &= 2(\cos \omega - 1) (j\sin 3\omega - \cos 3\omega) = 2(\cos \omega - 1) e^{-j3\omega}\end{aligned}$$

$$(b) |H(\omega)| = \sqrt{(2\cos \omega - 1)^2 \sin^2 3\omega + (2(\cos \omega - 1) \cos 3\omega)^2}$$

$$= 2|\cos \omega - 1|$$



$$(c) \angle H(\omega) = e^{-j3\omega}$$

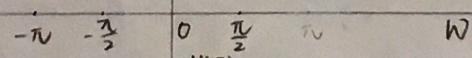


(d) $H(\omega)$ is a high pass filter.

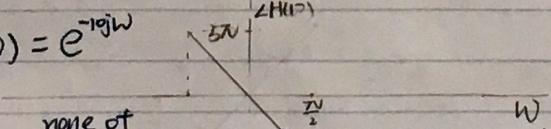
Question #4

$$(a) H(\omega) = e^{-10j\omega} = \cos(10\omega) - j\sin(10\omega)$$

$$(b) |H(\omega)| = \sqrt{\cos^2 10\omega + \sin^2 10\omega} = 1$$



$$(c) \angle H(\omega) = e^{-j10\omega}$$



(d) $H(\omega)$ is ~~not~~ low pass filter, band pass filter or high pass filter.

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Question #5

(a) $\Omega_s = 40\pi$

(b) $X(\omega) = 2\pi\delta(\omega) + j\pi[\delta(\omega+15) - \delta(\omega-15)] + \pi[\delta(\omega-66) + \delta(\omega+66)]$
 ~~$\Omega_s = 264$~~

(c)

$(a) X(\omega) = j\pi[\delta(\omega+20\pi) - \delta(\omega-20\pi)]$

$\Omega_{max} = 20\pi, \therefore \Omega_s = 40\pi$

(b) $X(\omega) = 2\pi\delta(\omega) + j\pi[\delta(\omega+15) - \delta(\omega-15)] + \pi[\delta(\omega-66) + \delta(\omega+66)]$

$\Omega_{max} = 66 \therefore \Omega_s = 132$

(c) $X(\omega) = \pi[\delta(\omega-1) + \delta(\omega+1)] * \pi[\delta(\omega-2) + \delta(\omega+2)] * \pi[\delta(\omega-3) + \delta(\omega+3)] * \pi[\delta(\omega-5) + \delta(\omega+5)]$

$= \pi^4 [\delta(\omega-3) + \delta(\omega+1) + \delta(\omega-1) + \delta(\omega+3)] * [\delta(\omega-8) + \delta(\omega+2) + \delta(\omega-2) + \delta(\omega+8)]$

$= \pi^4 [\delta(\omega-11) + \delta(\omega-1) + \delta(\omega-5) + \delta(\omega+5) + \delta(\omega-7) + \delta(\omega+3) + \delta(\omega-1) + \delta(\omega+9)]$

$+ \delta(\omega-9) + \delta(\omega+1) + \delta(\omega-3) + \delta(\omega+7) + \delta(\omega-5) + \delta(\omega+5) + \delta(\omega+1) + \delta(\omega+11)]$

$\Omega_{max} = 11 \therefore \Omega_s = 22$

(d) $X(\omega) = \frac{1}{2+j\omega}$

$\Omega_{max} =$

(e) $X(\omega) = \cos(4\omega)[U(\omega+4) - U(\omega-4)]$

$\Omega_{max} = 4 \therefore \Omega_s = 8$

(f) Let $x(t) * e^{-st} u(t) = z(t)$

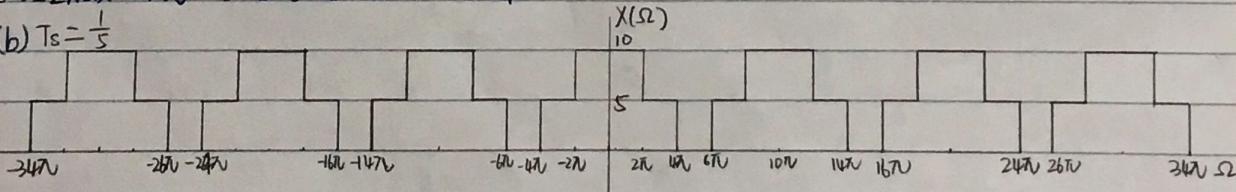
$\Rightarrow z(t) = \cos(4\omega)[U(\omega+4) - U(\omega-4)] \cdot \frac{1}{2+j\omega}$

$\Omega_{max} =$

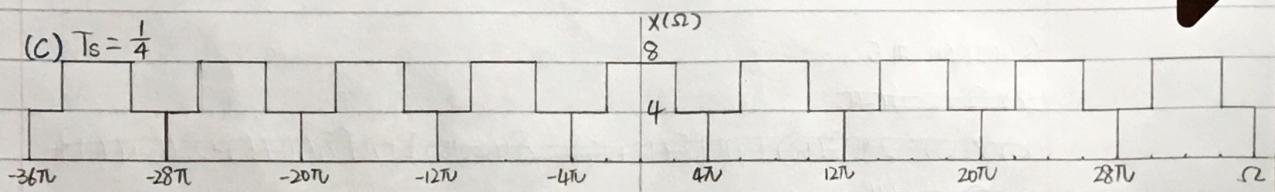
Question #6

(a) $\Omega_{max} = 4\pi \therefore \Omega_s = 8\pi \quad T_s = \frac{1}{4}$

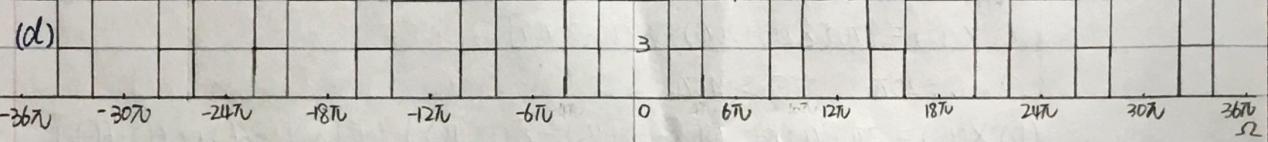
(b) $T_s = \frac{1}{5}$



$$(c) T_S = \frac{1}{4}$$



$$T_S = \frac{1}{3}$$



$$(e) T_S = \frac{1}{2}$$

