

数字信号处理 第十周作业

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作业内容: 4.36, 4.40, 4.53, 4.6, 4.7, 4.24,

4.25

Problem 4.36

SubProblem a

$$\omega_C = \Omega_C/T = 0.5\pi$$

$$\text{解得 } T \leq 1/400s$$

SubProblem b

由于降采样而无重叠, 频域被拉伸到原来二倍, 因此需要将其压缩, $T' = 2T = 1/200s$

Problem 4.40

容易得到, 最后的频谱为 $H(e^{j\omega/L})X(e^{j\omega})$, 那么其时域为 $x[n - 1/L]$

Problem 4.53

SubProblem a

如图 1, 图 2。

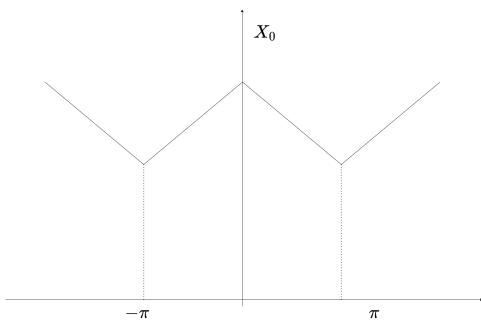


图 1

SubProblem b

$$Y_0(e^{j\omega}) = X(e^{j\omega})H_0(e^{j\omega}) + X(e^{j(\omega+\pi)})H_0(e^{j(\omega+\pi)})$$

SubProblem c

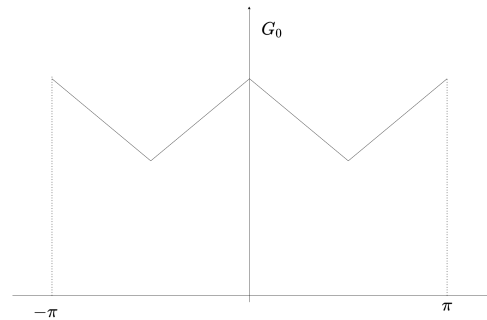


图 2

$$\begin{aligned} Y(e^{j\omega}) &= H_0(e^{j\omega})[X(e^{j\omega})H_0(e^{j\omega}) \\ &\quad + X(e^{j(\omega+\pi)})H_0(e^{j(\omega+\pi)})] \\ &\quad + H_0(e^{j(\omega+\pi)})[X(e^{j\omega})H_0(e^{j(\omega+\pi)}) \\ &\quad + X(e^{j(\omega+\pi)})H_0(e^{j\omega})] \end{aligned}$$

Problem 4.6

SubProblem a

$$\begin{aligned} H_c(\Omega) &= \int_{\mathbb{R}} h_c(t)e^{-j\Omega t}dt \\ &= \frac{1}{\alpha + j\Omega} \end{aligned}$$

其幅度特性如图 3。

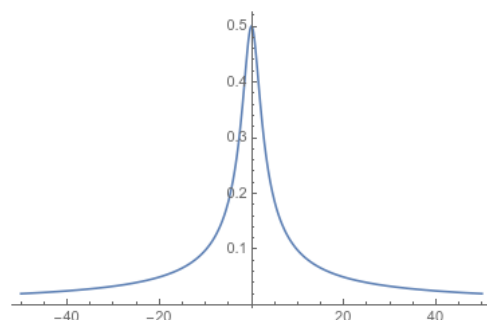


图 3

SubProblem b

$$h_d[n] = T e^{-anT} u[n]$$

$$H_d(e^{j\omega}) = T \frac{1}{1 - e^{-\alpha T - j\omega}}$$

$$|H_d(e^{j\omega})| = T \frac{1}{(1 - k \cos \omega)^2 + k^2 \sin^2 \omega}$$

where $k = e^{-\alpha T}$

那么最小值是在 $-\cos \omega$ 最大处，即 $\omega = \pi$ ，此时幅度为 $T/(e^{-\alpha T} + 1)^2$ ，当 $T \rightarrow \infty$ ，最小值为 T 。

Problem 4.7

SubProblem a

$$x_c(t) = s_c(t) + \alpha s_c(t - \tau_\alpha)$$

$$X_c(j\Omega) = (1 + \alpha e^{-j\Omega\tau_\alpha}) S_c(j\Omega)$$

SubProblem b

$$H(e^{j\omega}) = (1 + \alpha e^{-j\Omega\tau_\alpha/T})$$

SubProblem c

$$h[n] = \frac{1}{2\pi} \int_{-\pi}^{\pi} H(e^{j\omega}) e^{j\omega n} d\omega$$

$$= \frac{1}{2\pi} \left(\frac{2j \sin n\pi}{jn} + \alpha \frac{2j \sin(n - \tau_\alpha/T)}{j(n - \tau_\alpha/T)} \right)$$

$$= \delta(n) + \alpha \delta(n - \tau_\alpha/T)$$

Problem 4.24

$$\Omega_c = 2\pi 5 \times 10^3, \Omega_c = \omega_c/T$$

- a) $\omega_{c1} = \pi, \omega_{c2} = \pi$
- b) $\omega_{c1} = 0.5\pi, \omega_{c2} = 0.5\pi$
- c) $\omega_{c1} = 0.5\pi, \omega_{c2} = \pi$
- d) $\omega_{c1} = \pi, \omega_{c2} = 0.5\pi$

如图 4。

Problem 4.25

SubProblem a

如图 5

SubProblem b

要保证出现低通以及相邻波形不重叠的临界：

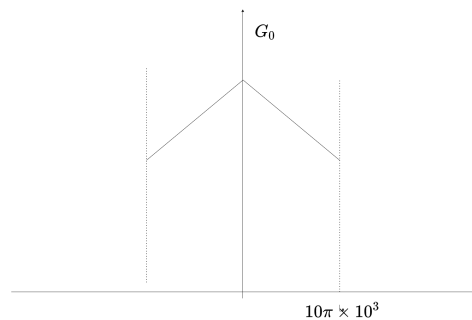
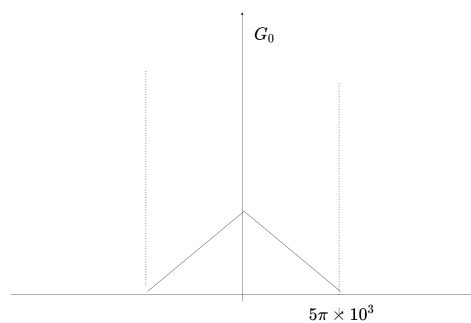
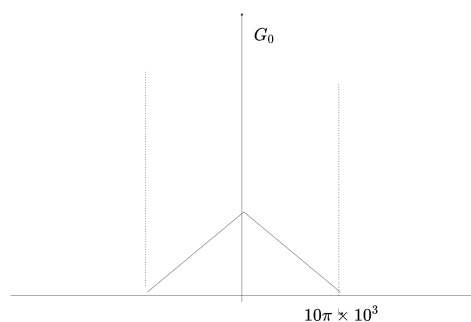
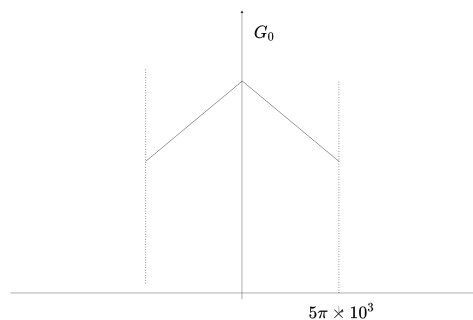


图 4

$$\Omega_c \leq \omega_c/T$$

$$2\pi/T - \Omega_c \geq \omega_c/T$$

$$\text{解得 } 0.125 \times 10^{-4} s \leq T \leq 0.875 \times 10^{-4} s$$

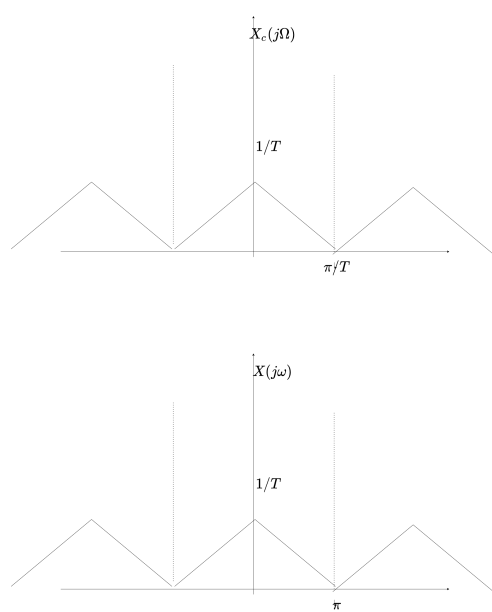


图 5