信号处理原理 第 10 次作业

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1

由题意:

$$\Delta f = f_s / M \leq 10\text{Hz}$$
$$f_s = \frac{1}{10^{-4}s} = 10\text{kHz}$$

因此

$$M \geq 1000$$
$$t_s = M / f_s \geq 0.1s$$

由 Nyquist 采样定理, 可采样的最高信号频率是

$$f_{max} = \frac{1}{2} f_s = 5\text{kHz}$$

2

(1)

$$t = \frac{128}{40\text{kHz}} = 3.2\text{ms}$$

(2)

将原频谱归一化为数字频谱

$$f = 5\text{kHz}$$
$$f_s = 40\text{kHz}$$
$$\omega_0 = \frac{2\pi f}{f_s} = \frac{\pi}{4}$$

对于数字信号 $x(n) = \sin(\omega_0 n)$, 其频谱 $X(\omega)$ 基频为 $\frac{\pi}{4}$, 故冲激所在位置是

$$\omega_1 = \frac{\pi}{4} \quad \omega_2 = 2\pi - \frac{\pi}{4} = \frac{7\pi}{4}$$

再对频域抽样, 有峰值的 DFT 点是

$$n_1 = \frac{\omega_1}{2\pi} \cdot 128 = 16$$
$$n_2 = 112$$

3

采样个数是

$$M = t \cdot f_s = 100$$

则频率分辨率为

$$\Delta f = f_s / M = 0.1\mathrm{kHz}$$

即, 为使三个简谐分量都能被区分, 其两两频率差不能小于分辨率. 那么

$$f_{2,max} = f_3 - \Delta f = 1.9\mathrm{kHz}$$
$$f_{2,min} = f_1 + \Delta f = 1.1\mathrm{kHz}$$