

Opg 4.6

$$a) \quad x(t) = [10 + \cos(2\pi 2000t)] \cos(2\pi \cdot 10^4 t) = v(t) \cos(2\pi f_c t)$$

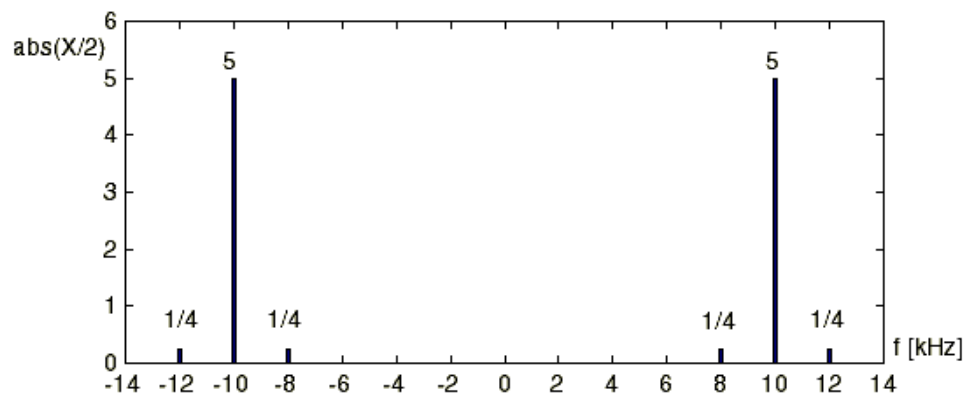
$$x(t) = [10 + \cos \omega_\Delta t] \cos(\omega_c t) = 10 \cos \omega_c t + \cos \omega_\Delta t \cos \omega_c t$$

$$= 10 \cos \omega_c t + \frac{e^{j\omega_\Delta t} + e^{-j\omega_\Delta t}}{2} \cdot \frac{e^{j\omega_c t} + e^{-j\omega_c t}}{2}$$

$$= 10 \frac{e^{j\omega_c t} + e^{-j\omega_c t}}{2} + \frac{1}{4} \left[e^{j(\omega_c + \omega_\Delta)t} + e^{-j(\omega_c - \omega_\Delta)t} + e^{j(\omega_c - \omega_\Delta)t} + e^{-j(\omega_c + \omega_\Delta)t} \right]$$

Med ovenstående talværdier:

$$x(t) = 5e^{j2\pi 10^4 t} + 5e^{-j2\pi 10^4 t} + \frac{1}{4}e^{j2\pi 1.2 \cdot 10^4 t} + \frac{1}{4}e^{j2\pi 0.8 \cdot 10^4 t} + \frac{1}{4}e^{-j2\pi 0.8 \cdot 10^4 t} + \frac{1}{4}e^{-j2\pi 1.2 \cdot 10^4 t}$$



b) Spektrum:

$$\left\{ \left(\frac{|X|}{2}, f \right) \right\} = \left\{ \left(\frac{1}{4}, -12k \right), (5, -10k), \left(\frac{1}{4}, -8k \right), \left(\frac{1}{4}, 8k \right), (5, 10k), \left(\frac{1}{4}, 12k \right) \right\}$$

Største fælles divisor i 8k, 10k og 12k er 2k.

Signalet er periodisk med $T = \frac{1}{2000} = 0.5 \cdot 10^{-3} = \underline{0.5[ms]}$.

c) Signalet skal samples korrekt.

$$\text{Dvs. } f_s > 2f_{\max} \text{ eller } f_s > 2 \cdot 12k \quad \Rightarrow \quad \underline{f_s > 24[kHz]}$$