

Lecture 5 exercises

$$V_{m1}(t) = 2 + \sin(40\pi t) + 3 \cos(60\pi t)$$

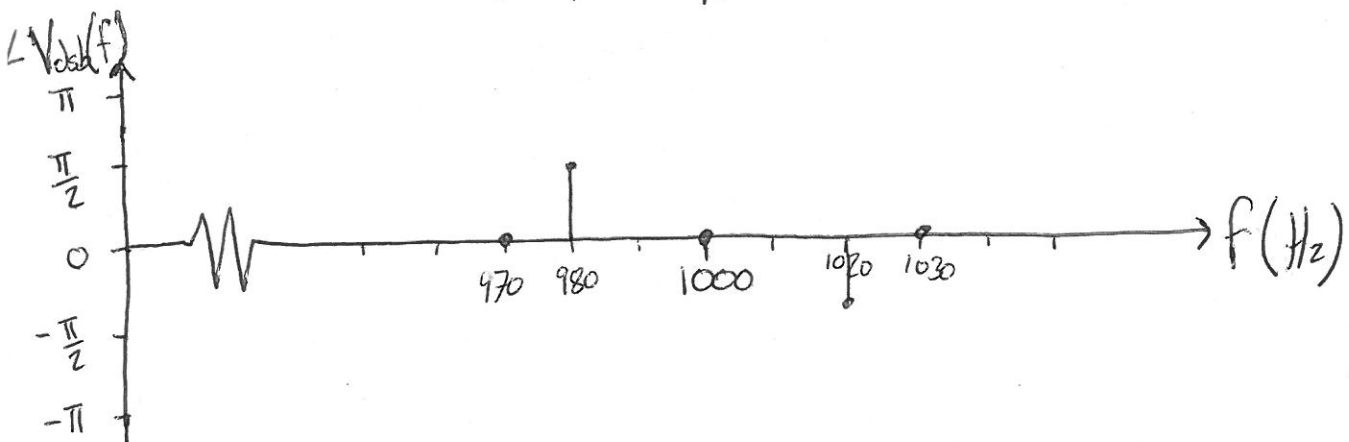
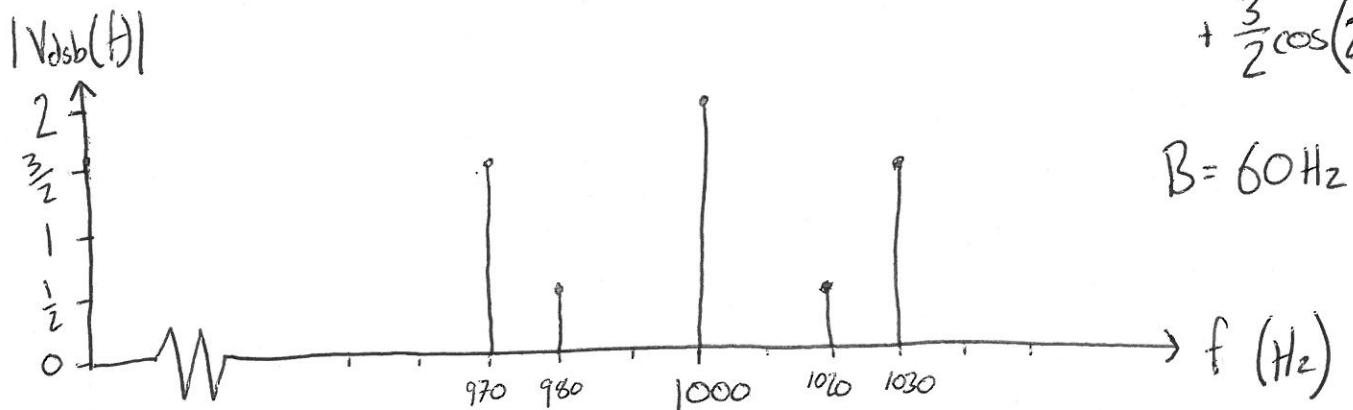
$$= 2 + \cos(40\pi t - \frac{\pi}{2}) + 3 \cos(60\pi t)$$

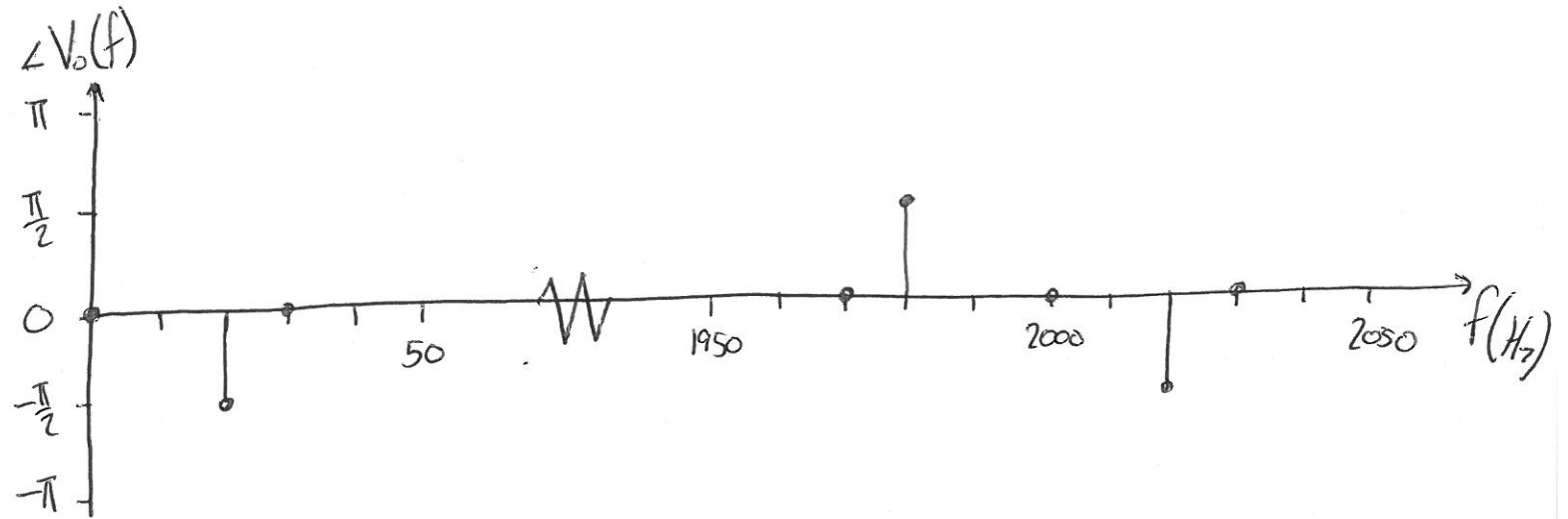
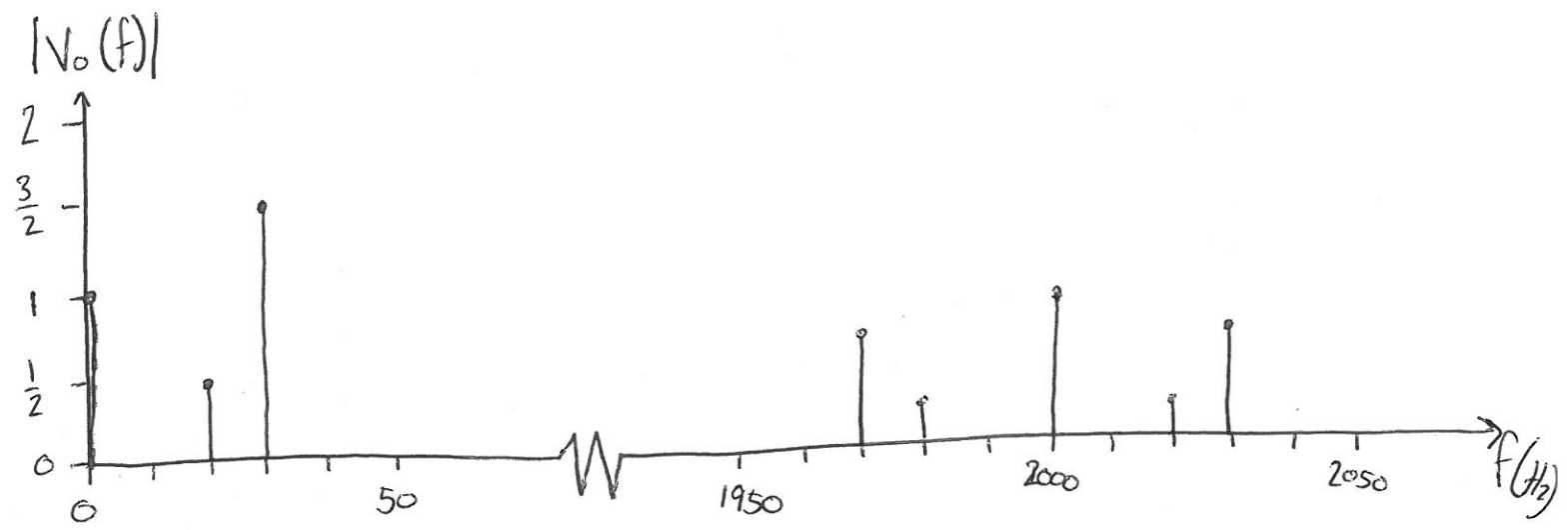
$$V_{m2}(t) = 3 \cos(20\pi t + \frac{\pi}{4}) + 2 \sin(60\pi t) - \cos(100\pi t)$$

$$= 3 \cos(20\pi t + \frac{\pi}{4}) + 2 \cos(60\pi t - \frac{\pi}{2}) + \cos(100\pi t - \pi)$$

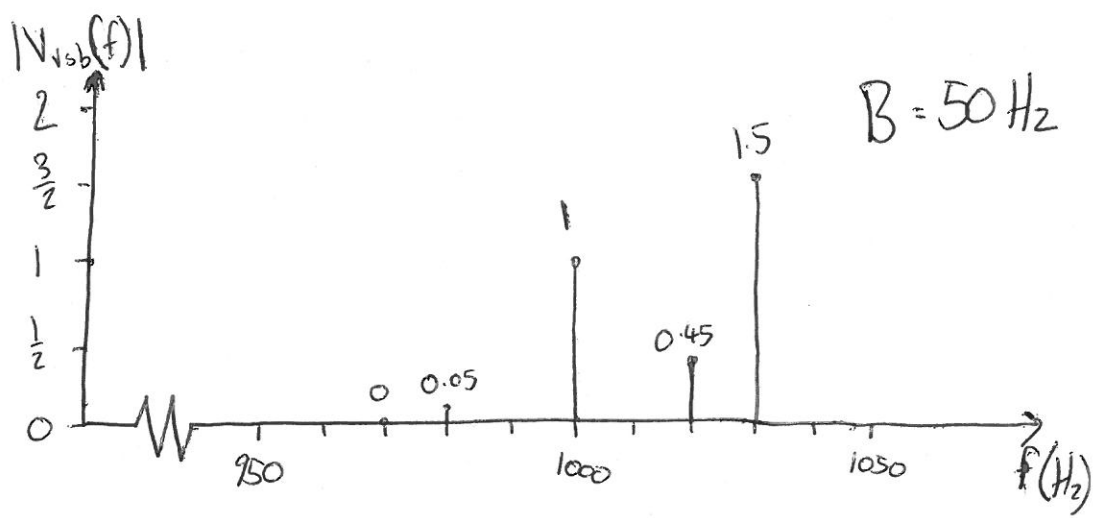
1. $V_{dsb}(t) = V_{m1}(t) \underbrace{V_c}_{1} \cos(\underbrace{2\pi f_c t}_{1000 \text{ Hz}})$

$$= \frac{3}{2} \cos(1940\pi t) + \frac{1}{2} \cos(1960\pi t + \frac{\pi}{2}) + 2 \cos(2000\pi t) + \frac{1}{2} \cos(2040\pi t - \frac{\pi}{2}) + \frac{3}{2} \cos(2060\pi t)$$

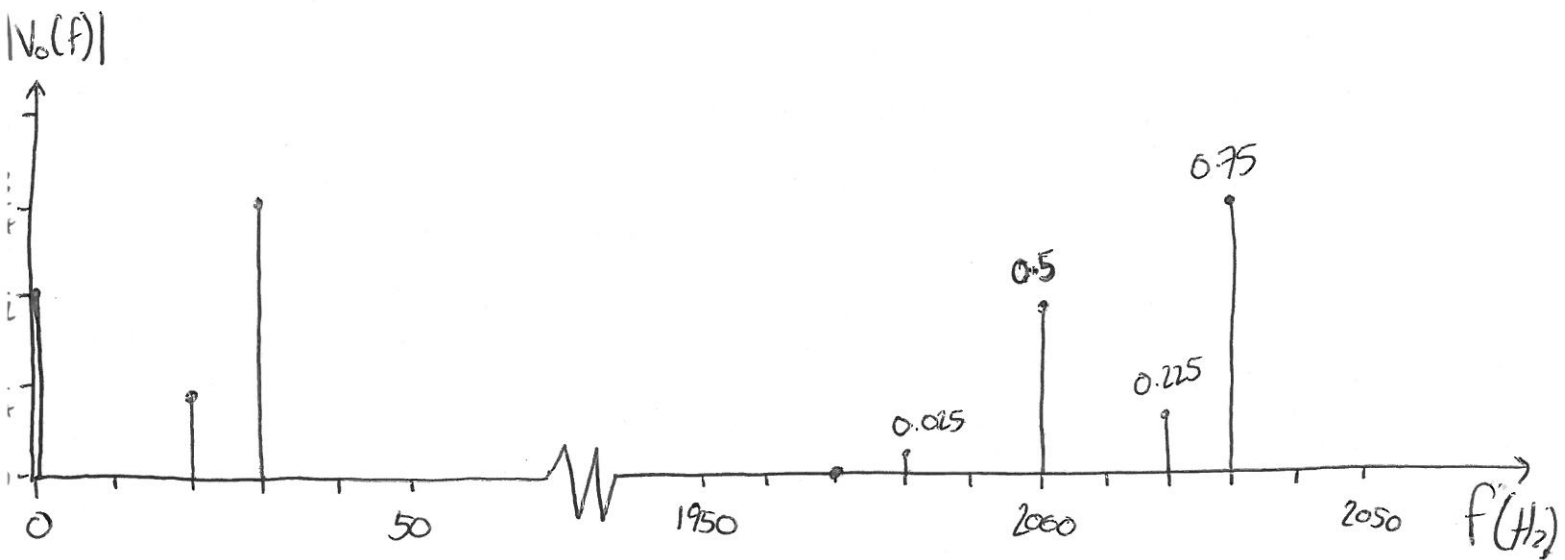




2. $H_{vsb}(970) = 0$
 $H_{vsb}(980) = 0.1$
 $H_{vsb}(1000) = 0.5$
 $H_{vsb}(1020) = 0.9$
 $H_{vsb}(1030) = 1$



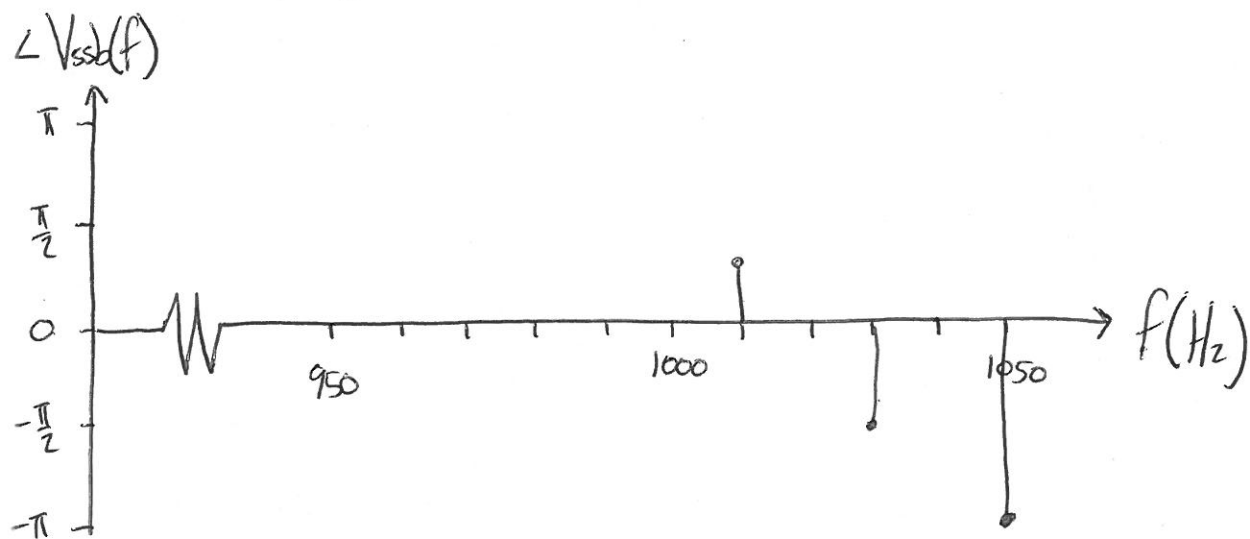
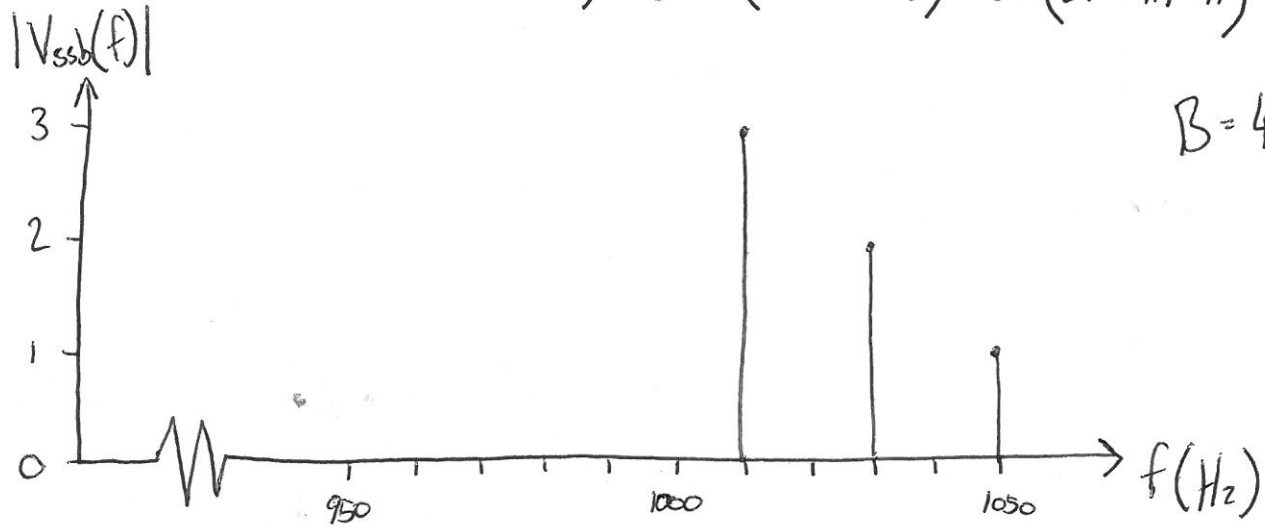
Phase is unchanged relative to Q1



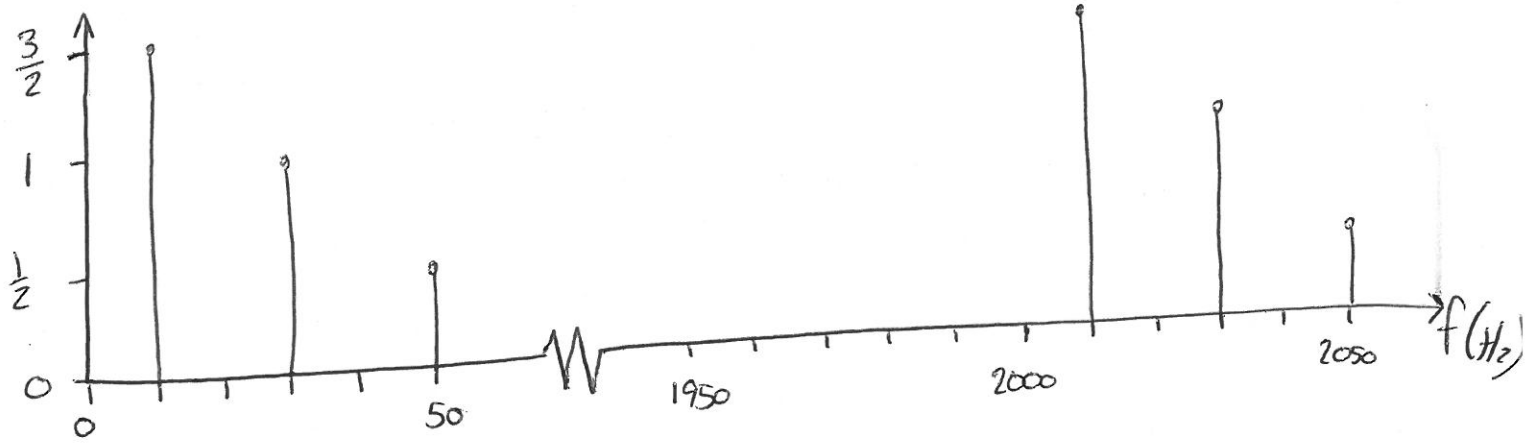
Phase is unchanged relative to Q1.

$$\begin{aligned}
 3. \quad V_{ssb}(t) &= \left(3\cos(20\pi t + \frac{\pi}{4}) + 2\cos(60\pi t - \frac{\pi}{2}) + \cos(100\pi t - \pi) \right) \cos(2\pi f_c t) \\
 &\quad - \left(3\sin(20\pi t + \frac{\pi}{4}) + 2\sin(60\pi t - \frac{\pi}{2}) + \sin(100\pi t - \pi) \right) \sin(2\pi f_c t) \\
 &= 3\cos(2020\pi t + \frac{\pi}{4}) + 2\cos(2060\pi t - \frac{\pi}{2}) + \cos(2100\pi t - \pi)
 \end{aligned}$$

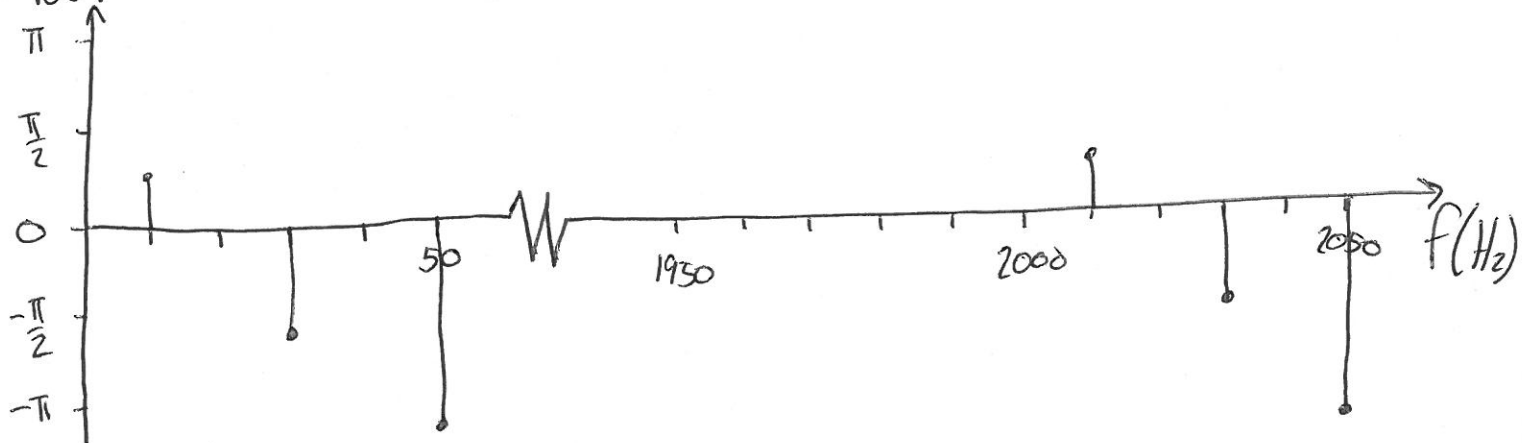
$\nwarrow 1000\text{Hz}$



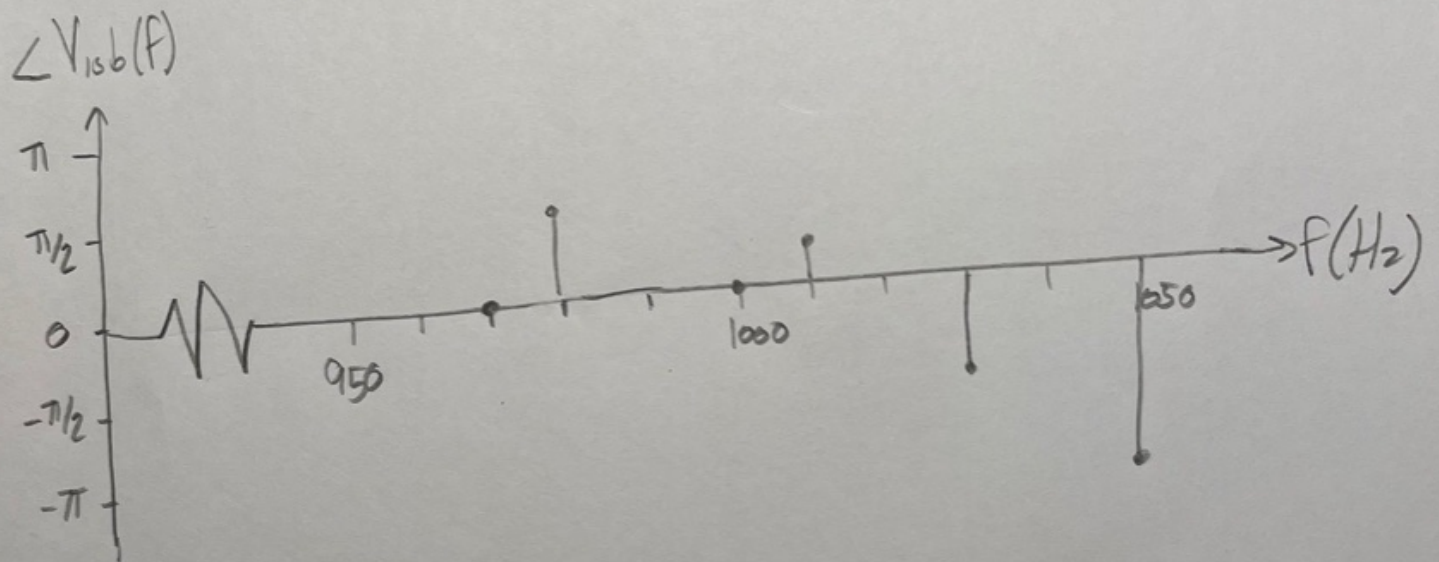
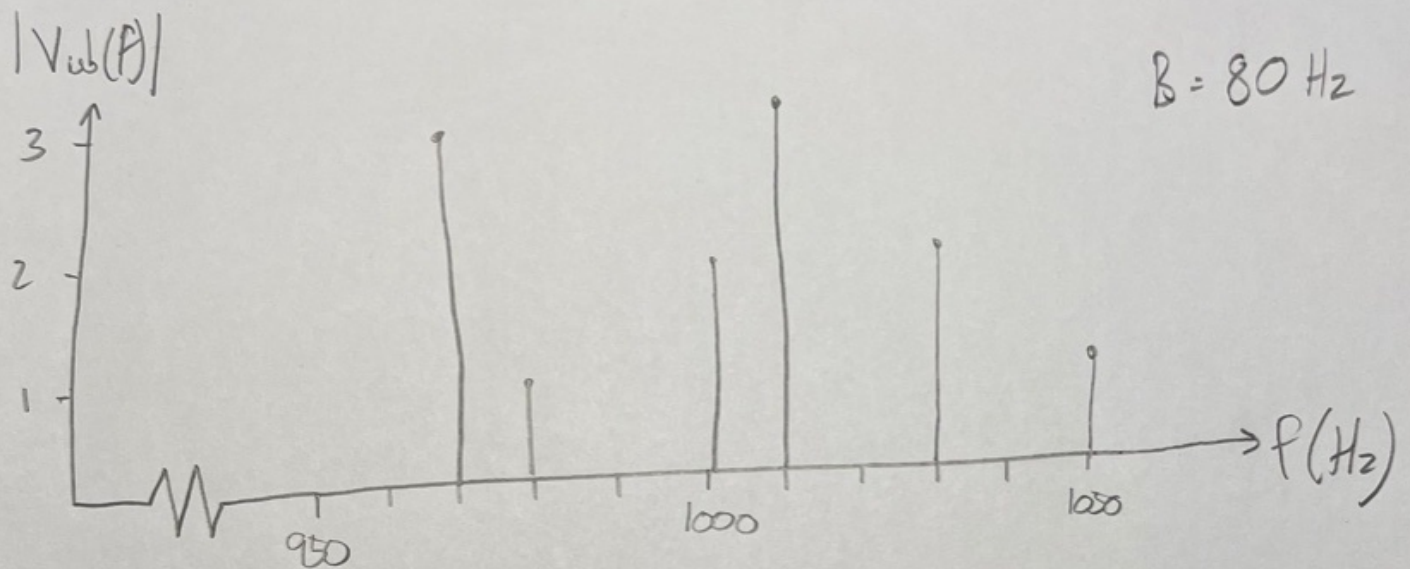
$$|V_o(f)|$$



$$\angle V_o(f)$$



4.
$$V_{\text{isb}}(t) = 3 \cos(1940\pi t) + \cos(1960\pi t + \frac{\pi}{2}) + 2 \cos(2000\pi t) + 3 \cos(2020\pi t + \frac{\pi}{4}) + 2 \cos(2060\pi t - \frac{\pi}{2}) + \cos(2100\pi t - \pi)$$



5.

$$\begin{aligned}
 V_{\text{gsm}}(t) &= \frac{3}{2} \cos(1940\pi t) + \frac{1}{2} \cos(1960\pi t + \frac{\pi}{2}) + 2 \cos(2000\pi t) + \frac{1}{2} \cos(2040\pi t - \frac{\pi}{2}) \\
 &\quad + \frac{3}{2} \cos(2060\pi t) + \frac{1}{2} \cos(1900\pi t + \frac{\pi}{2}) + \cos(1940\pi t) + \frac{3}{2} \cos(1980\pi t - \frac{3\pi}{4}) \\
 &\quad + \frac{3}{2} \cos(2020\pi t - \frac{\pi}{4}) + \cos(2060\pi t - \pi) + \frac{1}{2} \cos(2100\pi t + \frac{\pi}{2}) \\
 &= \frac{1}{2} \cos(1900\pi t + \frac{\pi}{2}) + \frac{5}{2} \cos(1940\pi t) + \frac{1}{2} \cos(1960\pi t + \frac{\pi}{2}) + \frac{3}{2} \cos(1980\pi t - \frac{3\pi}{4}) \\
 &\quad + 2 \cos(2000\pi t) + \frac{3}{2} \cos(2020\pi t - \frac{\pi}{4}) + \frac{1}{2} \cos(2040\pi t - \frac{\pi}{2}) + \frac{1}{2} \cos(2060\pi t) \\
 &\quad + \frac{1}{2} \cos(2100\pi t + \frac{\pi}{2})
 \end{aligned}$$

$$B = 100 \text{ Hz}$$

