A block diagram of an FSK modem is shown above. The VCOs in the transmitter and receiver have gains $K_{\text{OT}}$ and $K_{\text{OR}}$ respectively and the two VCO characteristics are shown in the graph above. You can assume that the PLL is locked.

(2 points) Find the two VCO gains, $K_{\text{OT}}$ and $K_{\text{OR}}$:

$$K_{\text{OT}} = \frac{1}{15} \frac{\text{kHz}}{\text{V}} = 0.067 \frac{\text{kHz}}{\text{V}}$$

$$K_{\text{OR}} = \frac{4}{15} \frac{\text{kHz}}{\text{V}} = 0.267 \frac{\text{kHz}}{\text{V}}$$

(2 points) Express $f_i$ as a function of $V_{\text{Tx}}(t)$ and $K_{\text{OT}}$ in the form $y = mx + b$:

$$f_i = K_{\text{OT}} V_{\text{Tx}}(t) + 9.5 \text{kHz}$$

(2 points) Express $f_{\text{osc}}$ as a function of $V_{\text{Rx}}(t)$ and $K_{\text{OR}}$ in the form $y = mx + b$:

$$f_{\text{osc}} = K_{\text{OR}} V_{\text{Rx}}(t) + 8 \text{kHz}$$

(6 points) For the case when $V_{\text{Tx}}(t) = 8.5$ volts (constant), find $f_i$, $f_{\text{osc}}$, and $V_{\text{Rx}}(t)$:

$$f_i = 10.07 \text{kHz}$$

$$f_{\text{osc}} = f_i \Rightarrow V_{\text{Rx}}(t) = 7.74 \text{V}$$

(3 points) For the case when $V_{\text{Tx}}(t) = (7.5 \sin(\omega t) + 7.5)$ volts, find $V_{\text{Rx}}(t)$:

$$V_{\text{Rx}}(t) = 1.88 \sin(\omega t) + 7.5$$