equation of envelope of AM signal $\Rightarrow$ $A_c\,[m(t)+1]$

ratio of 2 successive peaks of AM signal $\approx \dfrac{A_c\,[m(t+\frac{1}{f_c})+1]}{A_c\,[m(t)+1]}$

$$= \frac{A_m \sin(2\pi f_m t + 2\pi \frac{f_m}{f_c}) + 1}{A_m \sin(2\pi f_m t) + 1}$$

taking $t = \frac{1}{2f_m}$, where gradient of envelope is most negative and for easier comparison of successive peaks

ratio of 2 successive peaks at $t = \frac{1}{2f_m}$ $\approx \dfrac{A_m \sin(\pi + 2\pi \frac{f_m}{f_c}) + 1}{A_m \sin(\pi) + 1}$

$$= A_m \sin(\pi + 2\pi \tfrac{f_m}{f_c}) + 1$$

$$= 1 - A_m \sin(2\pi \tfrac{f_m}{f_c})$$

$\boxed{\text{Determining effect of } A_m}$

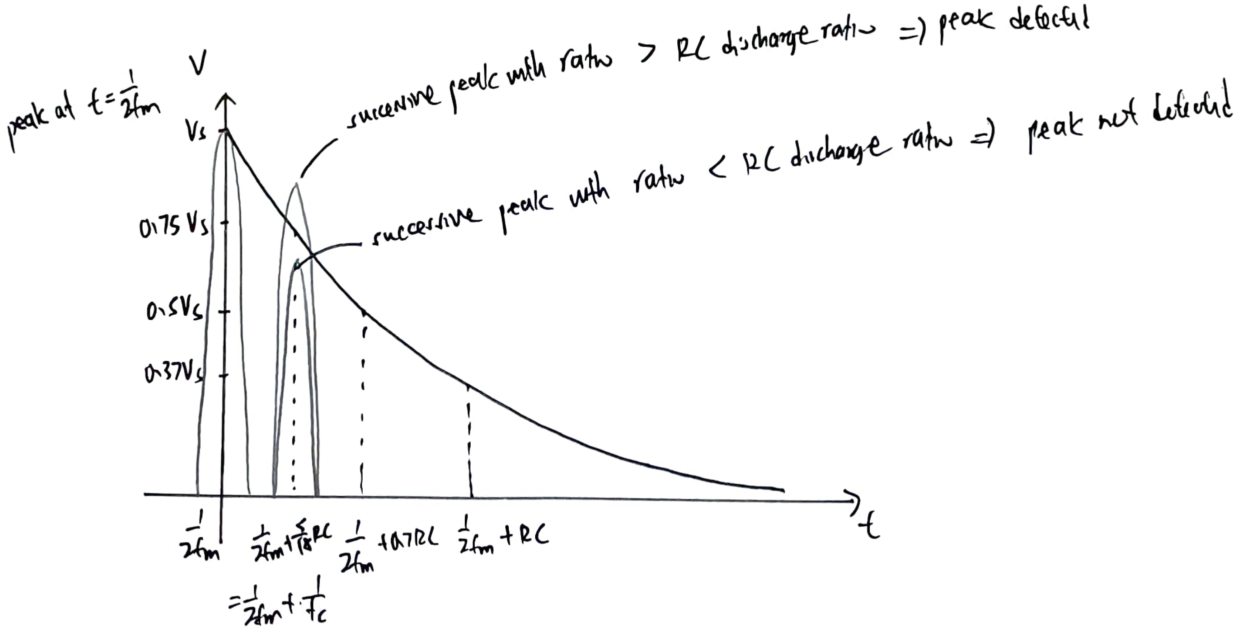
using our current values of f_m, f_c and RC $\Rightarrow$ $\frac{f_m}{f_c} = \frac{1}{20}$ $\quad \frac{\frac{1}{f_c}}{RC} = \frac{5}{18}$

RC discharge ratio $\approx e^{-\frac{\frac{1}{f_c}}{RC}} \approx 0.757$

ratio of 2 successive peaks with $A_m = 0.5$ $\approx 1 - \frac{1}{2}\sin(\frac{\pi}{10})$
≈ 0.845

ratio of 2 successive peaks with $A_m = 0.2$ $\approx 1 - 0.2\sin(\frac{\pi}{10})$
≈ 0.938

ratio of 2 successive peaks with $A_m = 0.9$ $\approx 1 - 0.9\sin(\frac{\pi}{10})$
≈ 0.722



As A_m approaches 1, ratio between successive peaks decrease, requiring RC time constant to be smaller so that the capacitor can discharge more to reach the next peak. It is harder to accomodate RC time constant due to smaller range which has to be closer to $\frac{1}{f_c}$.

Determining effect of $\frac{f_m}{f_c}$

using our current values of $A_m = \frac{1}{2}$, $f_c = 20\text{kHz}$ & $RC \Rightarrow \frac{\frac{1}{f_c}}{RC} = \frac{5}{18}$

RC discharge ratio $\approx e^{-\frac{\frac{1}{f_c}}{RC}} \approx 0.757$

ratio of 2 successive peaks with $f_m = 1\text{kHz} \approx 1 - \frac{1}{2}\sin\left(2\pi\cdot\frac{1}{20}\right)$

≈ 0.845

ratio of 2 successive peaks with $f_m = 2\text{kHz} \approx 1 - \frac{1}{2}\sin\left(2\pi\frac{1}{10}\right)$

≈ 0.706

ratio of 2 successive peaks with $f_m = 500\text{Hz} \approx 1 - \frac{1}{2}\sin\left(2\pi\frac{1}{40}\right)$

≈ 0.921

The smaller the $\frac{f_m}{f_c}$ ratio is, the larger the ratio between each successive peaks. Graphically, it corresponds to more peaks in each period, hence successive peaks are closer to each other.

when f_c is changed as compared to f_m, RC discharge ratio also changes proportionally

$f_c = 40\,kHz$, $\Rightarrow \dfrac{\frac{1}{f_c}}{RC} = \dfrac{25}{18}$, RC discharge $\approx e^{-\frac{\frac{1}{f_c}}{RC}} \approx 0.570$

$f_c = 10\,kHz$, $\Rightarrow \dfrac{\frac{1}{f_c}}{RC} = \dfrac{10}{18}$, RC discharge $\approx e^{-\frac{\frac{1}{f_c}}{RC}} \approx 0.574$

Decreasing f_m gives a wider range of possible RC values as compared to increasing f_c. Overall, reducing $\frac{f_m}{f_c}$ ratio allows for a wide range of RC time constant values.