review questions in AM

Ex

A given AM signal was modulated using a non linear device modulator. The output of the modulator is given by $v_o(t) = a_1 \cos w_c t + a_2 f(t) \cos w_c t$

If $a_1 = 0.01$, $a_2 = 0.001$, $f(t) = 4 \cos w_m t$

determine

a) The modulation index

b) The power efficiency of the modulator

Solution

a) $v_o(t) = \phi_{AM}(t) = a_1\left[1 + \frac{a_2}{a_1} f(t)\right] \cos w_c t$

$= 0.01\left[1 + \frac{0.001}{0.01} 4 \cos w_m t\right] \cos w_c t$

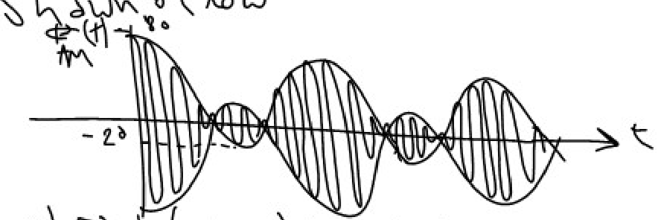
$= 0.01\left[1 + 0.4 \cos w_m t\right] \cos w_c t$

$\boxed{m = 0.4}$

b) $\eta = \frac{m^2}{2+m^2}$

$= \frac{0.4^2}{2+(0.4)^2} \simeq 7.4\%$

Ex2 For the DSB-LC modulated signal shown below



a) Find the modulation index, m

b) write a mathematical expression for $\phi_{AM}(t)$

c) sketch the line spectrum of $\phi_{AM}(t)$

d) Determine the amplitude of the additional carrier that must be added to reduce the modulation index to 20%

Solution

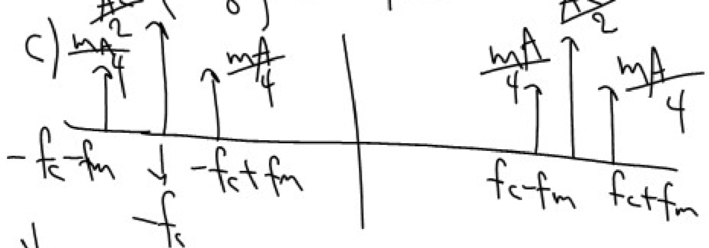
a) $m = \frac{V_{max} - V_{min}}{V_{max} + V_{min}} = \frac{80 - -20}{80 + -20} = \frac{100}{60} = 1.667$

b) $\phi_{AM}(t) = A_c(1 + m \cos w_m t) \cos w_c t$

$V_{max} = (1+m) A_c$

$80 = \left(1 + \frac{10}{6}\right) A_c \Rightarrow A_c = 30$ volt

c)



d) $m = \frac{A_m}{A_c}$

$1.667 = \frac{A_m}{30} \Rightarrow A_m = 50V$

Now it is required to reduce the modulation index to 20%

$0.2 = \frac{50}{A_c} \Rightarrow A_c = 250V$

EX3 An AM modulator is operating with a modulation index of 0.7. The modulation input is

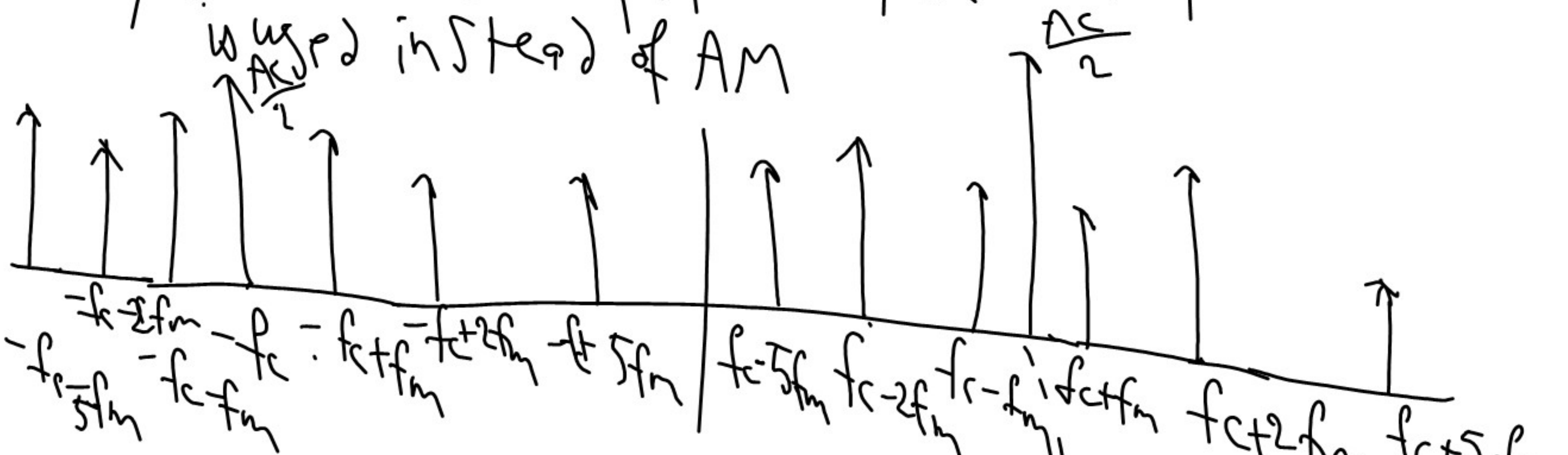
$$f(t) = 2\cos 2\pi f_m t + \cos 4\pi f_m t + 2\cos 10\pi f_m t$$

a) Sketh the amplitutde Spectrum of $\phi_{AM}(t)$

b) what is the efficiency of the AM modulator

c) Sketh the amplitude spectrum If DSB-SC is used instead of AM modulation

d) Sketch the amplitude spectrum If SSB-SC^{+} is used instead of AM



b) $$\eta = \frac{P_S}{P_C + P_S}$$

$$P_S = \overline{f^2(t)} = \frac{2^2}{2} + \frac{(1)^2}{2} + \frac{(2)^2}{2} = 4.5 \text{ Watt}$$

$$P_C = \frac{A_c^2}{2}$$

$$V_{max} = (1+m)A_c$$

$$V_{max} = 2+1+2 = 5$$

$$5 = (1+0.7)A_c \Rightarrow A_c = \frac{5}{1.7}$$