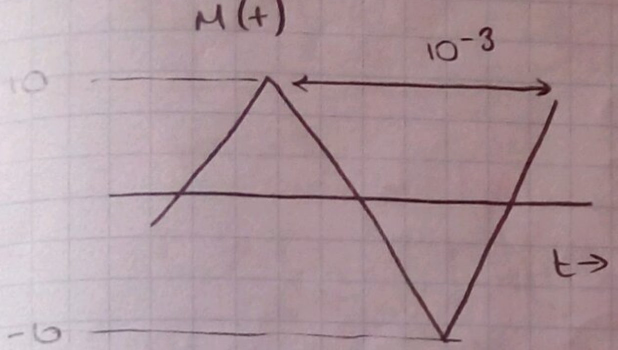
EEEN - 322 PS-4

1) AM signal $\rightarrow$ $[A + m(t)].\cos w_c t$



a) $\mu = \frac{mp}{A}$ $0.5 = \frac{10}{A} \sim A = 20$

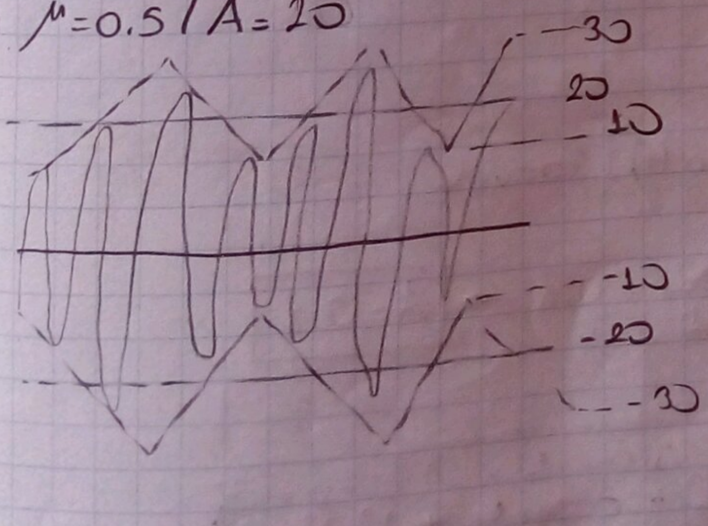
b) $\mu = 1 = \frac{mp}{A} \sim A = 10$

c) $\mu = 2 = \frac{mp}{A} \sim A = 5$

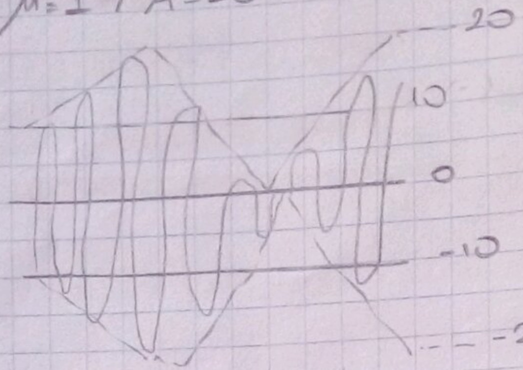
d) $\mu = \infty = \frac{10}{A} \sim A = 0$

$\hookrightarrow$ AM signal $= \underbrace{m(t).\cos w_c t}_{\text{DSB signal}}$

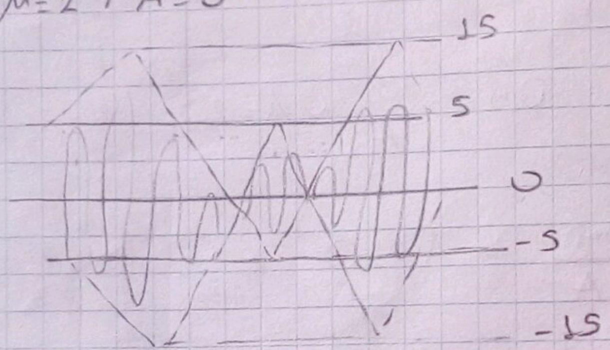
a) $\mu = 0.5$ / $A = 20$



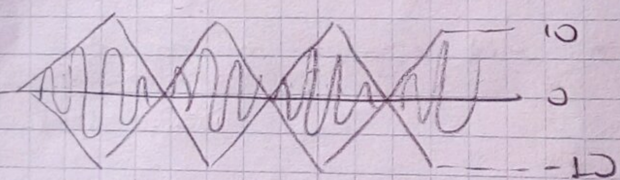
b) $\mu = 1$ / $A = 10$



c) $\mu = 2$ / $A = 5$



d) $\mu = \infty$ / $A = 0$



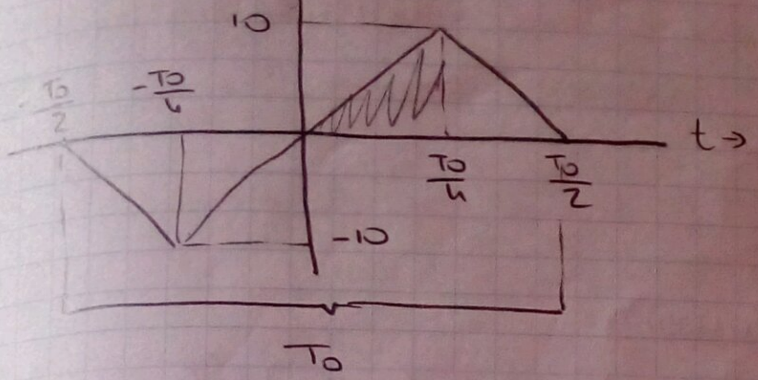
2) $\mu = 0.8$

a) AM Signal $= [A + m(t)] \cos \omega_c t$

$$\mu = \frac{m_p}{A} = \frac{10}{A} = 0.8 \rightarrow \boxed{A = 12.8}$$

$$AM \rightarrow \underline{\underline{12.8}} \cdot \cos \omega_c t + 12.8 \cdot m(t) \cdot \cos \omega_c t$$

$$P_{carrier} = \frac{A^2}{2} = \frac{(12.8)^2}{2} = \boxed{78.125}$$



$$P_M = \frac{1}{T_0}\int_0^{T_0} |m(t)|^2 dt = \frac{1}{(T_0/4)}\int_0^{T_0/4} |m(t)|^2 dt$$

$$\left.\begin{aligned} m(t) &= 0, \quad t = 0 \\ m(t) &= 10, \quad t = \frac{T_0}{4} \end{aligned}\right\} \; m(t) = \frac{10}{(T_0/4)} = \boxed{\frac{40}{T_0} t}$$

$T_0 = 10^{-3}$

$$P_M = \frac{1}{(10^{-3}/4)}\int_0^{10^{-3}/4} \left(\frac{40t}{10^{-3}}\right)^2 dt$$

$$= \frac{1}{(10^{-3}/4)}\left[20t^2\right]_0^{10^{-3}/4} = \boxed{33.34}$$

Sideband power → $P_s = \frac{P_M}{2} = \boxed{16.67}$

$$\text{Efficiency} = \frac{P_{side\text{-}band}}{P_{side} + P_{carrier}} = \frac{16.67}{78.125 + 16.67} \times 100$$

$$= \boxed{19.66\ \%}$$

3) $m_1(t) = \cos 100t$

$m_2(t) = \cos 100t + 2\cos 300t$

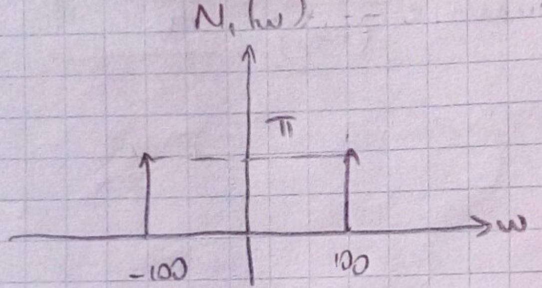
$m_3(t) = \cos 100t \cdot \cos 500t$

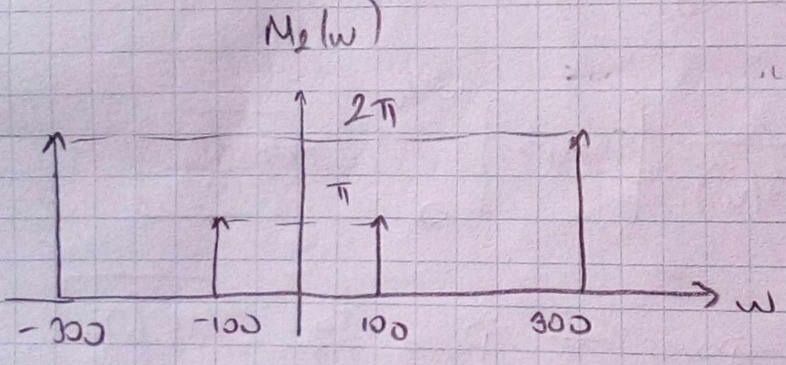
$M_1(w) = \pi\left(\delta(w-100) + \delta(w+100)\right)$

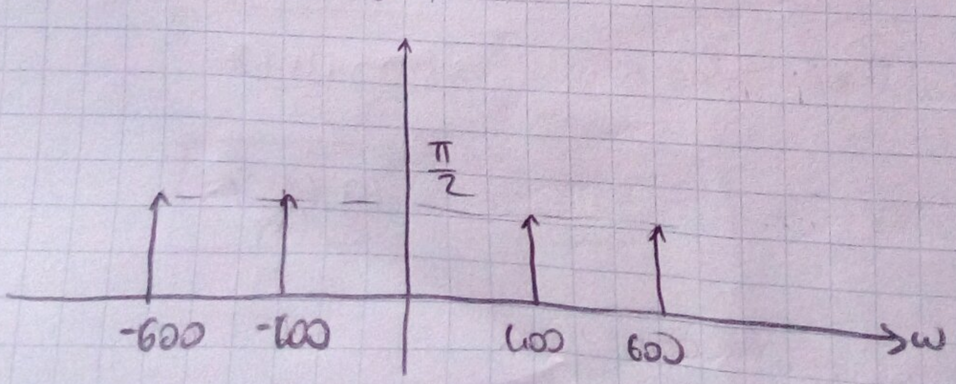
$M_2(w) = \pi\left(\delta(w-100) + \delta(w+100)\right) + 2\pi\left(\delta(w-300) + \delta(w+300)\right)$

$m_3(t) = \frac{1}{2}\left(\cos 400t + \cos 200t\right)$

$M_3(w) = \frac{\pi}{2}\left[\delta(w-400) + \delta(w+400) + \delta(w-600) + \delta(w+600)\right]$



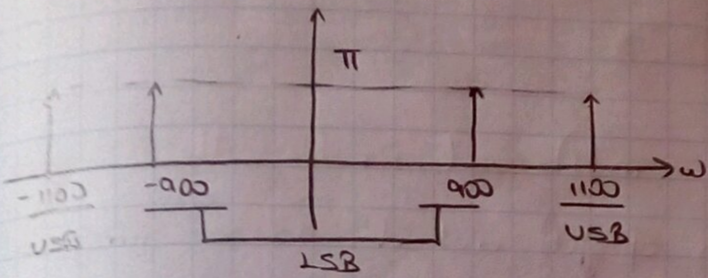




$\varphi_{DSBSC_1}(t) = 2m_1(t) . \cos 1000t$

$= 2 . \cos 100t . \cos 1000t$

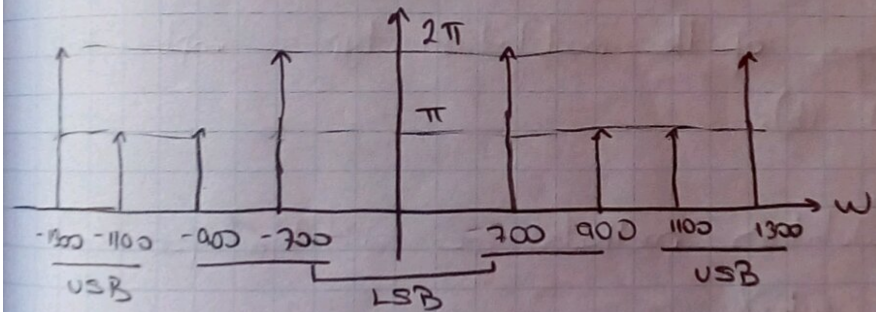
$\varphi_{DSB_1}(w) = 2 . \frac{1}{2} [M_1(w-1000) + M_1(w+1000)]$



$\varphi_{DSB_2}(t) = 2m_2(t) \cos 1000t$

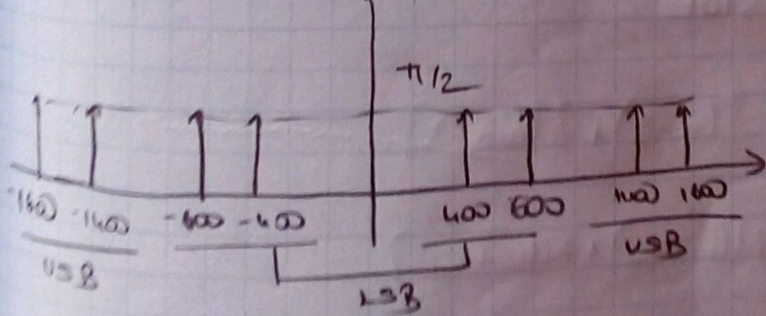
$= 2 . [\cos 100t + 2\cos 300t] . \cos 1000t$

$\varphi_{DSB_2}(w) = 2 . \frac{1}{2} [M_2(w-1000) + M_2(w+1000)]$

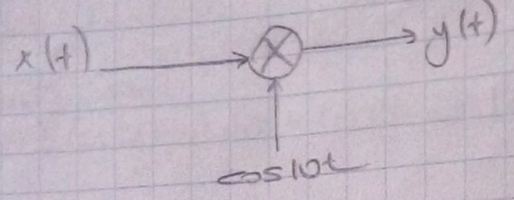


$\varphi_{DSB_3}(t) = 2m_3(t) . \cos 1000t$

$\varphi_{DSB_3}(w) = 2 . \frac{1}{2} [M_3(w-1000) + M_3(w+1000)]$



4) For the figure shown below, answer the following questions



a) If $x(t) = m(t)$ where $m(t) = \cos t$, write the mathematical expression of $y(t)$ and its fourier Transform $Y(\omega)$, and sketch them.

b) If $x(t) = A + m(t)$ where $A = 4$ and $m(t) = 3\cos t$, " " " " " " " " ". Calculate the modulation index μ.

c) Give the names of the modulation types implemented in (a) and (b).

d) which demodulation methods are suitable for (a) and (b)? why?

a) $y(t) = m(t).\cos \omega_c t$

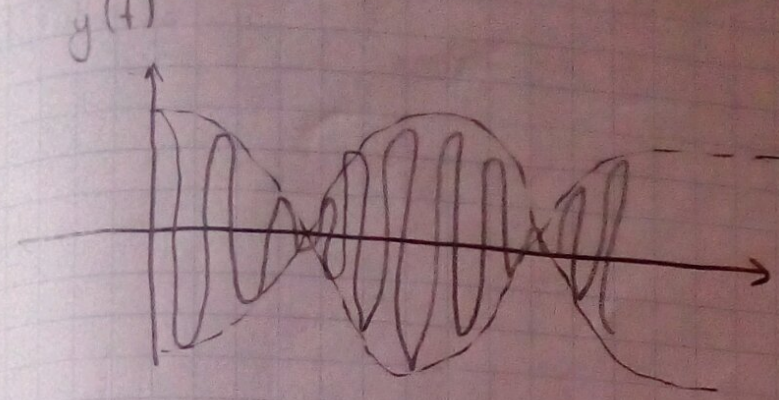
$= \cos t . \cos 10t$

$M(\omega) = \pi [\delta(\omega - 1) + \delta(\omega + 1)]$

$Y(\omega) = \frac{\pi}{2} [M(\omega - 10) + M(\omega + 10)]$

$= \frac{\pi}{2} [\delta(\omega - 10 - 1) + \delta(\omega - 10 + 1)]$
$+ \delta(\omega + 10 - 1) + \delta(\omega + 10 + 1)]$

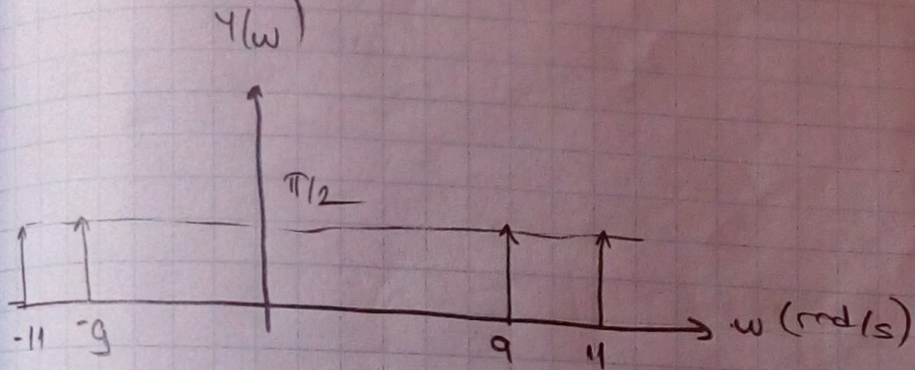
$= \frac{\pi}{2} [\delta(\omega - 11) + \delta(\omega - 9) + \delta(\omega + 9) + \delta(\omega + 11)]$



Dasted line is the envelope $m(t) = \cos t$

$\omega = 1\ rad/s \Rightarrow T_0 = 2\pi\ s$

* $\cos t$ makes one cycle in 2π seconds, $\cos 10t$ makes ten cycles in the same time interval.



(b) $y(t) = [A + m(t)] \cdot \cos \omega_c t$

$= [4 + 3\cos t] \cdot \cos 10t$

$= 4\cos 10t + 3\cos t \cdot \cos 10t$

$Y(\omega) = 4\pi[\delta(\omega - 10) + \delta(\omega + 10)] + \frac{3\pi}{2}[\delta(\omega - 11) + \delta(\omega - 9) + \delta(\omega + 9) + \delta(\omega + 11)]$

$m_p = 3 \quad A = 4 \quad \} \ \mu = \frac{m_p}{A} = \frac{3}{4} = 0.75$ (or, 75%)