No.: .... Date: ....

Esmund Lim Signal Tutorial 12

1) $P(t) = \sin(200\pi t)$

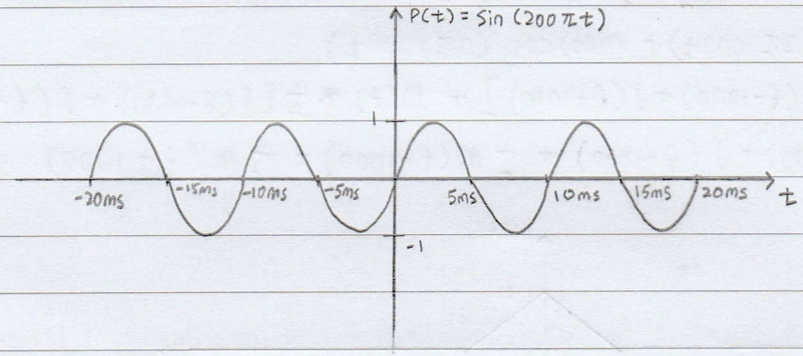
$$m(t) = \begin{cases} P(t), & \text{if } p(t) \geq 0 \\ -P(t), & \text{otherwise} \end{cases}$$

Time domain waveform

The signal m(t) is then modulated by the conventional AM to produce the AM signal

$$x_{AM}(t) = [1 + 2m(t)] \cos(2000\pi t)$$

a)



$2\pi f = 200\pi$

$2f = 200$

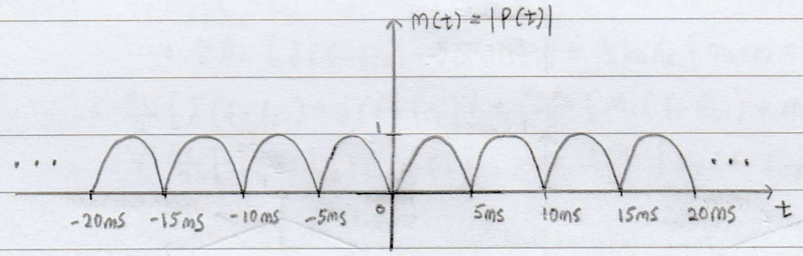
$f = 100Hz$

$T = \frac{1}{f}$

$= \frac{1}{100}$

$= 0.01s$

$= 10ms$



$P_p = \frac{A^2}{2}$

$= \frac{1}{2}(1)^2$

$= \frac{1}{2} W$

$P_m = \frac{1}{2}(1)^2$

$= \frac{1}{2} W$

square of both function is the same

$\therefore P_p = P_m$

b) $x_{AM}(t) = \underbrace{[1 + 2m(t)]}_{\text{envelope}} \underbrace{\cos(2000\pi t)}_{\text{fast changing carrier wave}}$

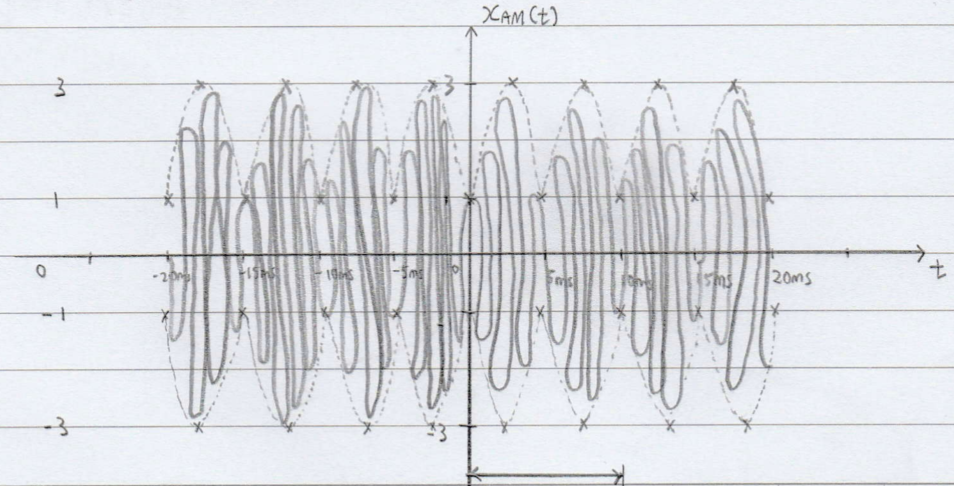
$= [1 + 2m(t)] \cos(2\pi \underbrace{1000}_{\text{carrier frequency}} t)$

$T = \frac{1}{f_c}$

$= \frac{1}{1000Hz}$

$= 1ms$

in 10ms, will have 10 cycle



10cycles of carrier wave

2) A message signal $m(t)$ is modulated by a conventional AM scheme to produce

$$x_{AM}(t) = 2[1 + 0.5m(t)]\cos(2000\pi t)$$

The amplitude spectrum of $m(t)$ is given by

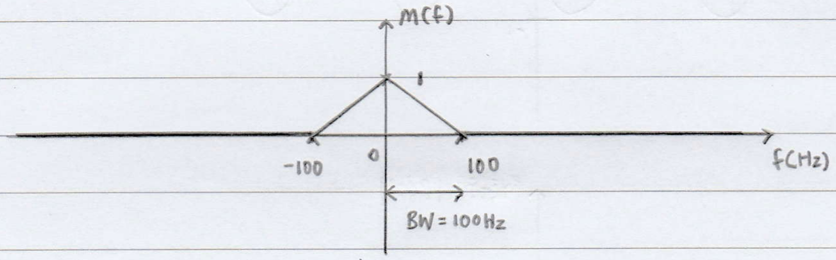
$$M(f) = \begin{cases} 1 - |0.01f| , & \text{for } -100\,\text{Hz} \le f \le 100\,\text{Hz} \\ 0 , & \text{otherwise} \end{cases}$$

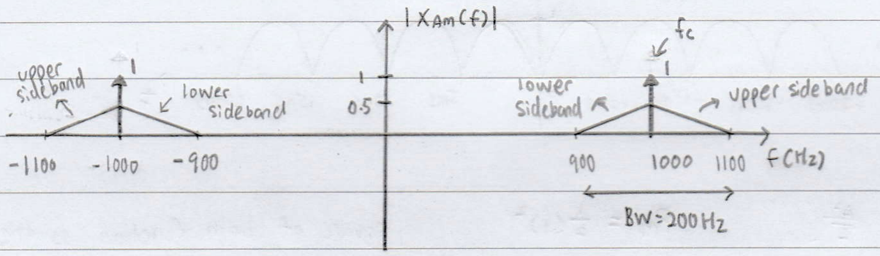
a) $$x_{AM}(t) = 2[1 + 0.5m(t)]\cos(2\pi 1000t)$$
$$= 2\cos(2\pi 1000t) + m(t)\cos(2\pi 1000t)$$

in ω_0 got π
$f = \frac{1}{2}$
$\omega_0 = 2\pi f$
$f = \frac{\omega_0}{2\pi}$
$= \frac{\pi}{2\pi} = \frac{1}{2}$

$$X_{AM}(f) = \tfrac{1}{2}(2)[\delta(f-1000) + \delta(f+1000)] + M(f) * \tfrac{1}{2}[\delta(f-1000) + \delta(f+1000)]$$
$$= \delta(f-1000) + \delta(f+1000) + \tfrac{1}{2}M(f-1000) + \tfrac{1}{2}M(f+1000)$$

$\left[\begin{array}{l} x(t) * \delta(t-T_0) \\ = x(t-T_0) \end{array}\right]$





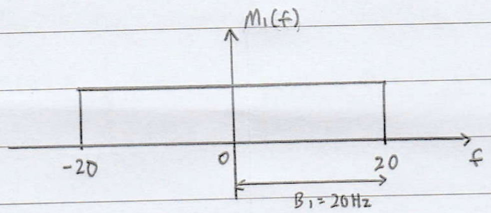
$B_m = 100\,\text{Hz}$

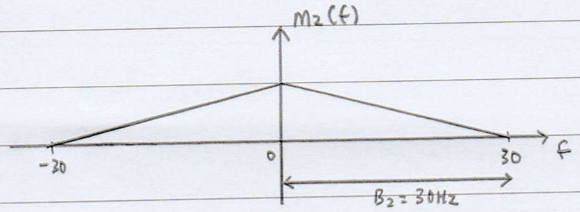
$B_{X_{AM}} = 200\,\text{Hz}$

No.:

Date:

3)





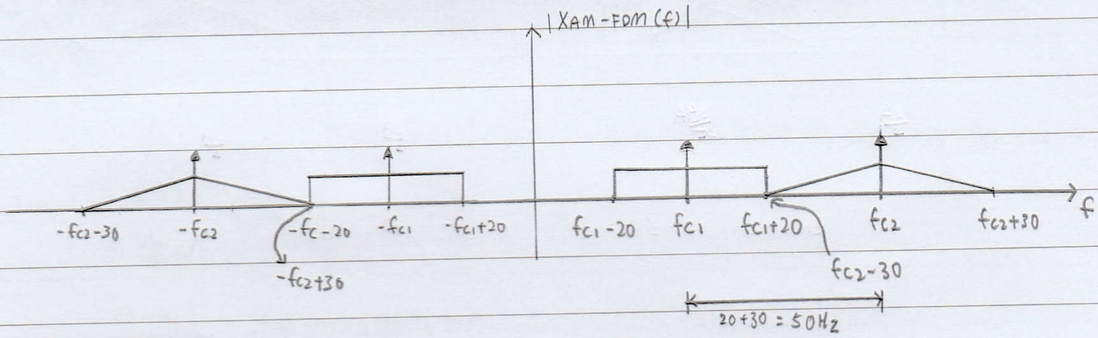
$$x_{AM-FDM}(t) = A_c\left[1 + k_a m_1(t)\right]\cos(2\pi f_{c1} t) + A_c\left[1 + k_a m_2(t)\right]\cos(2\pi f_{c2} t)$$

* By using the same f_c, it will not be able to separate the two signal at the receiver as they are overlapping in both time and frequency domain

→ assign f_{c1} to modulate $m_1(t)$
f_{c2} to modulate $m_2(t)$

$$x_{AM-FDM}(t) = A_c\cos(2\pi f_{c1}t) + A_c k_a m_1(t)\cos(2\pi f_{c1}t) + A_c\cos(2\pi f_{c2}t) + A_c k_a m_2(t)\cos(2\pi f_c t)$$

$$X_{AM-FDM}(f) = \frac{1}{2}A_c\left[\delta(f-f_{c1}) + \delta(f+f_{c1})\right] + \frac{1}{2}k_a A_c\left[M_1(f) * \left(\delta(f-f_{c1}) + \delta(f+f_{c1})\right)\right]$$
$$+ \frac{1}{2}A_c\left[\delta(f-f_{c2}) + \delta(f+f_{c2})\right] + \frac{1}{2}k_a A_c\left[M_2(f) * \left(\delta(f-f_{c2}) + \delta(f+f_{c2})\right)\right]$$
$$= \frac{A_c}{2}\left[\delta(f-f_{c1}) + \delta(f+f_{c1})\right] + \frac{k_a A_c}{2}\left[M_1(f-f_{c1}) + M_1(f+f_{c1})\right]$$
$$+ \frac{A_c}{2}\left[\delta(f-f_{c2}) + \delta(f+f_{c2})\right] + \frac{k_a A_c}{2}\left[M_2(f-f_{c2}) + M_2(f+f_{c2})\right]$$



minimum separation → no gap between them

$BW = 2 \times 50Hz$
$= 100Hz$