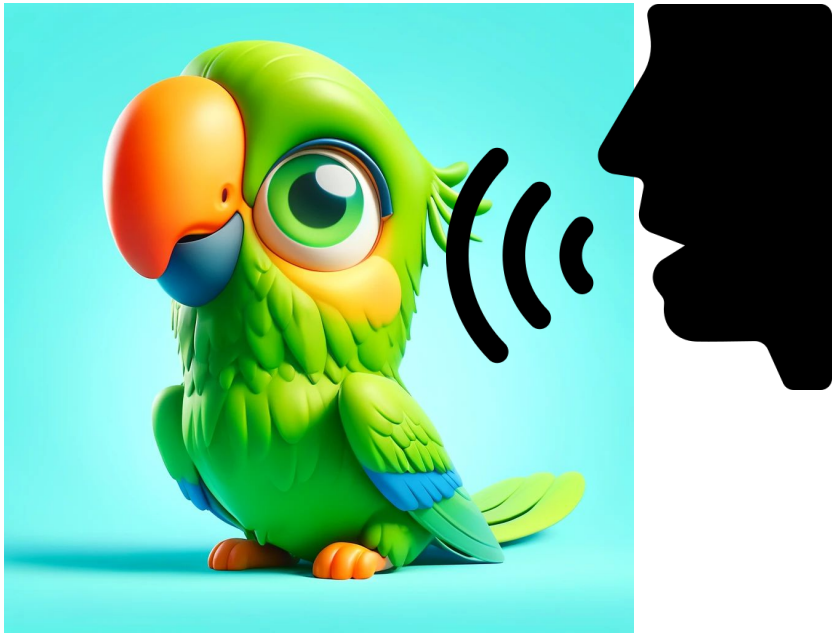
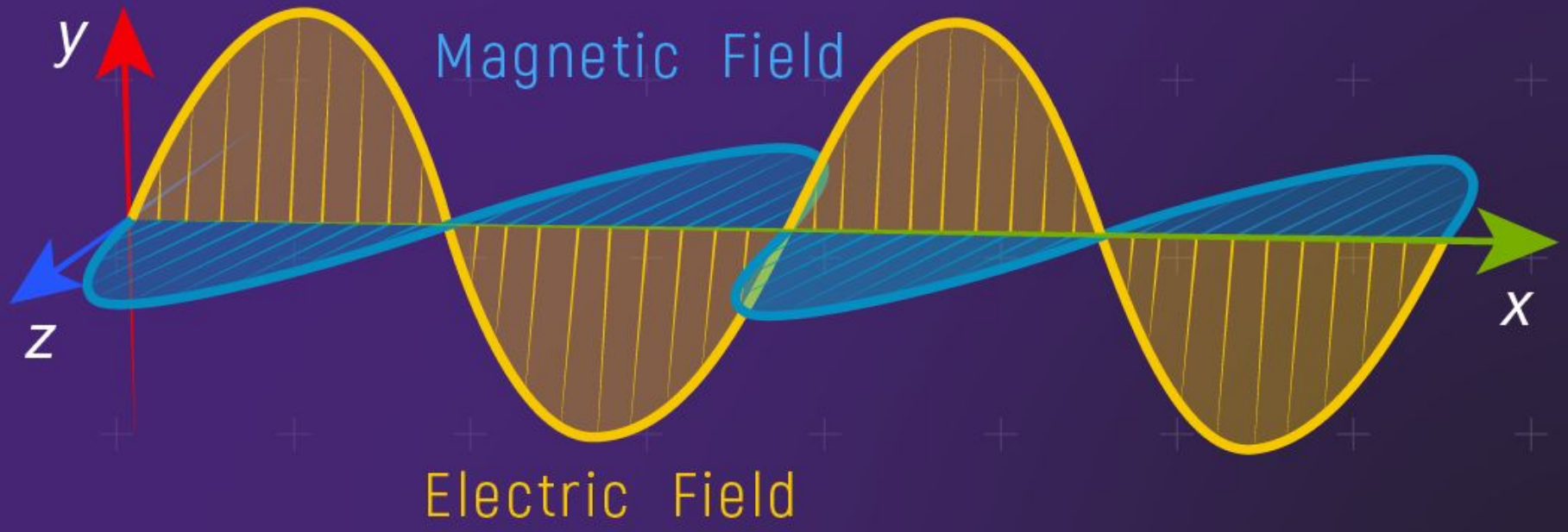
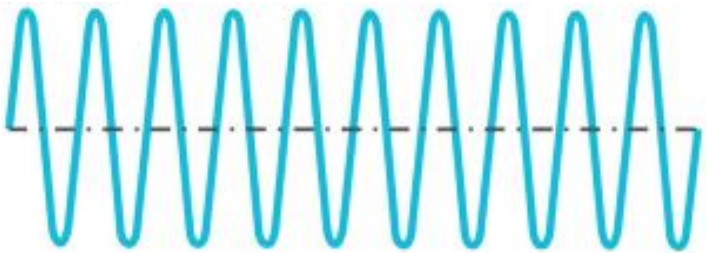
Comunicaciones Inalámbricas:
Modulación

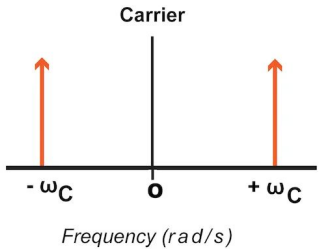


ELECTROMAGNETIC WAVE

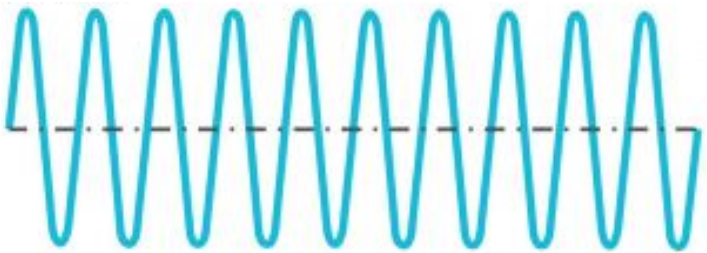


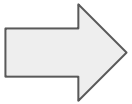
$$A\cos(2\pi f_c t)$$

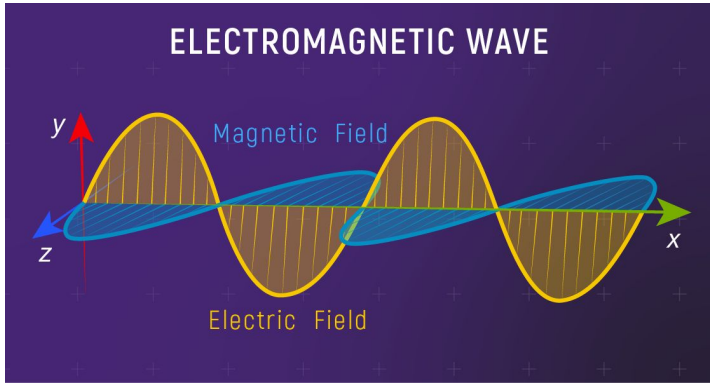


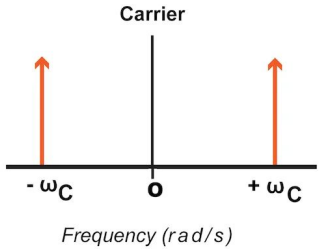


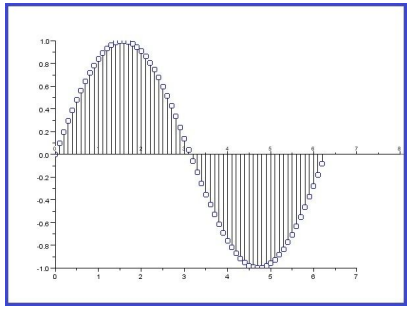
$$A\cos(2\pi f_c t)$$

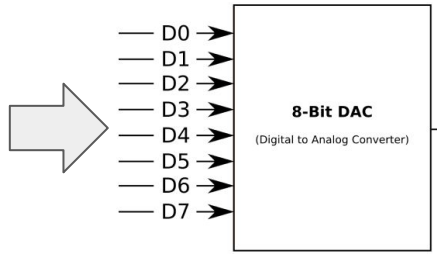


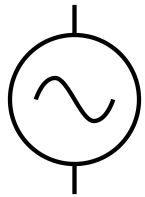


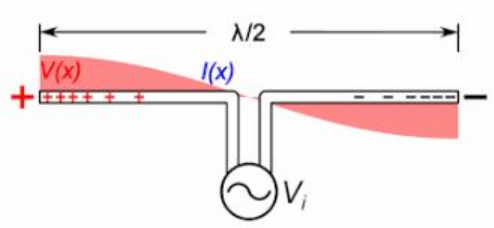

ELECTROMAGNETIC WAVE
y
Magnetic Field
z
x
Electric Field

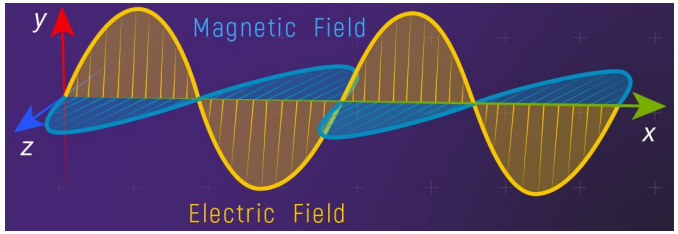

Carrier
- ωC
o
+ ωC
Frequency (rad/s)

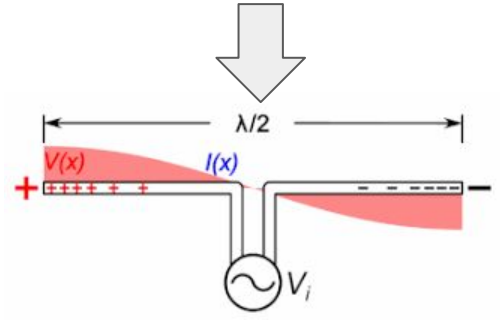


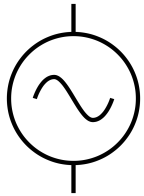

D0
D1
D2
D3
D4
D5
D6
D7
8-Bit DAC
(Digital to Analog Converter)

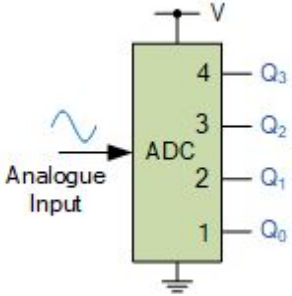


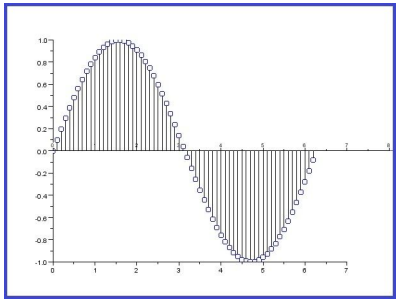

λ/2
V(x)
I(x)
+
−
V_i

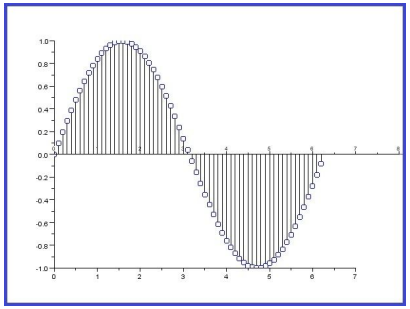

y
Magnetic Field
z
x
Electric Field


λ/2
V(x)
I(x)
+
V_i

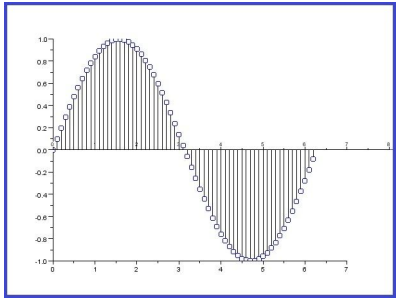



V
4
3
2
1
Q_3
Q_2
Q_1
Q_0
ADC
Analogue
Input



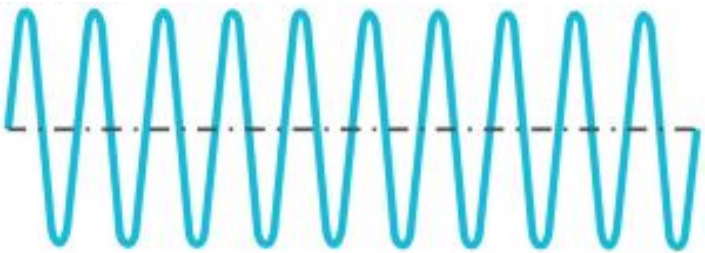


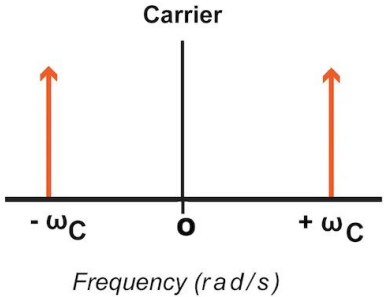
CAJA NEGRA



Onda Sinusoidal

$$A\cos(2\pi f_c t)$$





Y… ¿Cómo puedo enviar el mensaje en una sinusoidal?

En la Amplitud: $s(t) = x(t)\cos(2\pi f_c t)$

En la Frecuencia: $s(t) = A\cos(2\pi(f_c t + \int_0^t x(T)dT))$)

Nota sobre la frecuencia de una onda sinusoidal

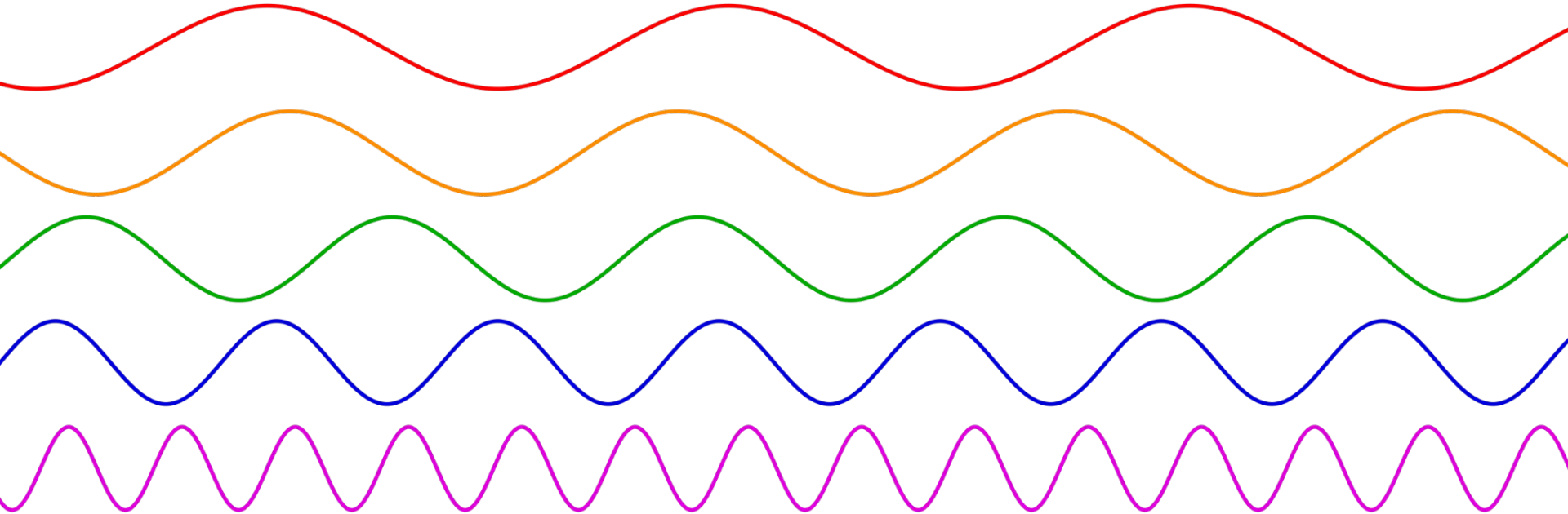
- La frecuencia es la derivada del argumento de la sinusoidal dividido 2 pi!

$$A\cos(2\pi f_c t) \Rightarrow 2\pi f_c t \Rightarrow f_c$$

$$A\cos(2\pi(f_c t + \int_0^t x(T)dT)) \Rightarrow 2\pi(f_c t + \int_0^t x(T)dT) \Rightarrow f_c + x(t)$$

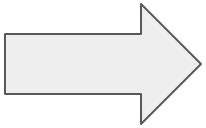
Y como podemos mandar varios mensajes en simultáneo?

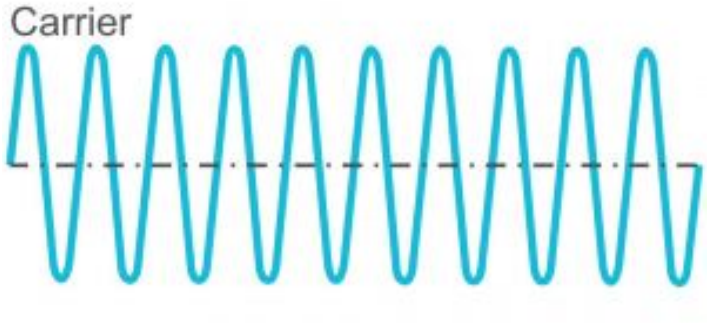
Diferentes Frecuencias de las portadoras!



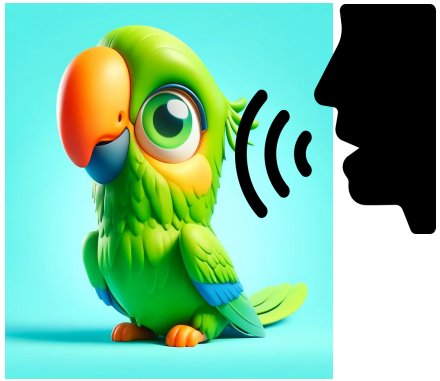
En Resumen…

Portadora





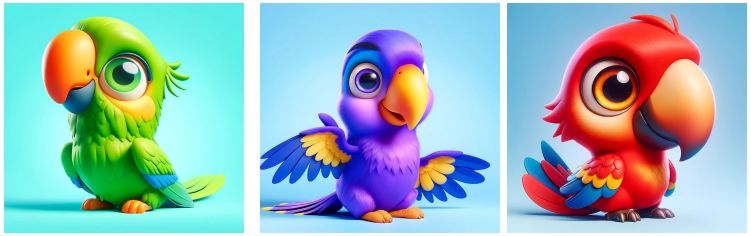
Modulación

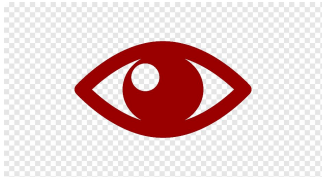


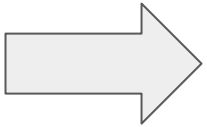
$$s(t) = x(t)\cos(2\pi f_c t)$$

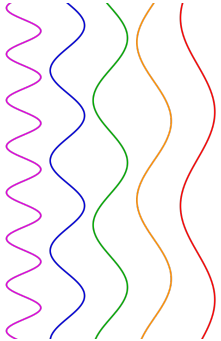
$$s(t) = A\cos(2\pi f_c + \int_0^t x(T)dT)$$

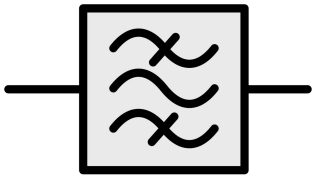
Uso del Medio Compartido











Entrando a las matemáticas…

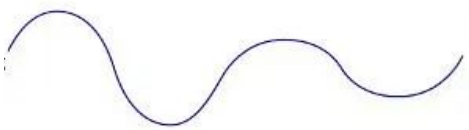
Señal y Portadora:

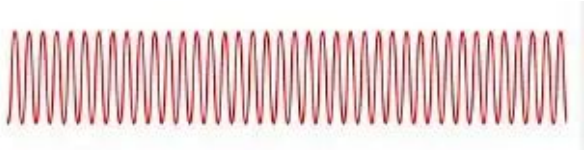
Matemática

$x(t)$

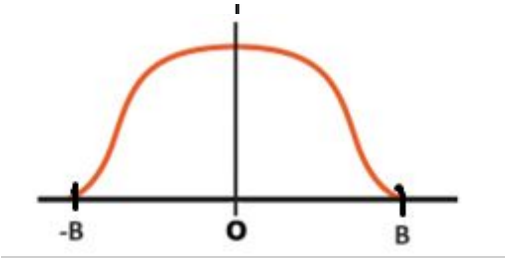
$\cos(2\pi f_c t)$

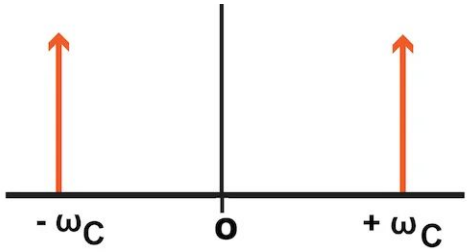
Tiempo



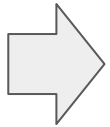


Frecuencia





Modulación AM

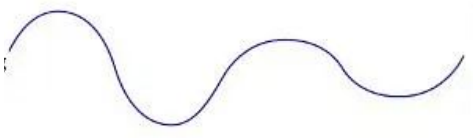
$x(t)$ $\cos(2\pi f_c t)$  $s(t) = x(t)\cos(2\pi f_c t)$

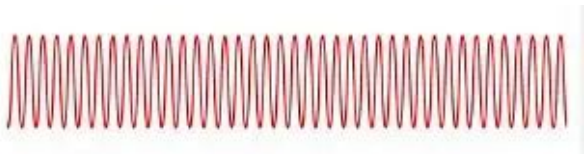
Modulación AM

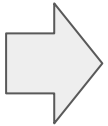
$x(t)$

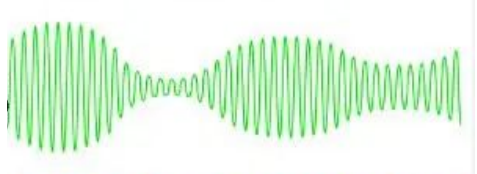
$\cos(2\pi f_c t)$

$s(t) = x(t)\cos(2\pi f_c t)$







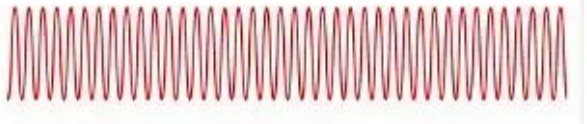


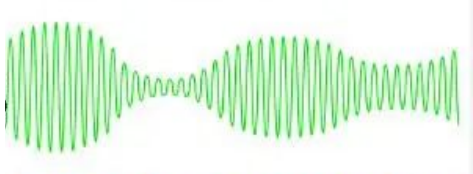
Modulación AM

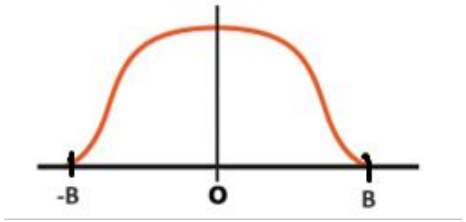
$x(t)$

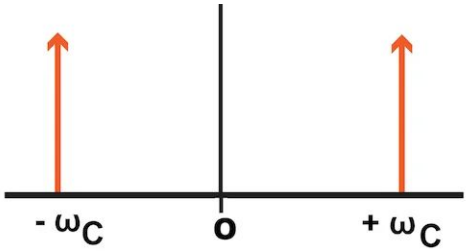
$\cos(2\pi f_c t)$

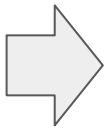
$s(t) = x(t)\cos(2\pi f_c t)$

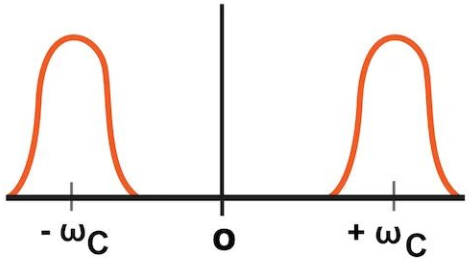






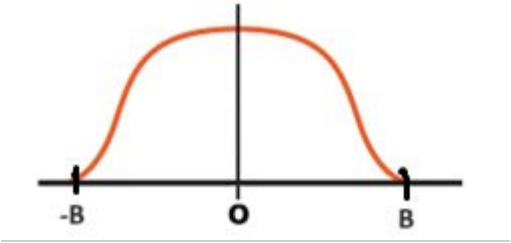




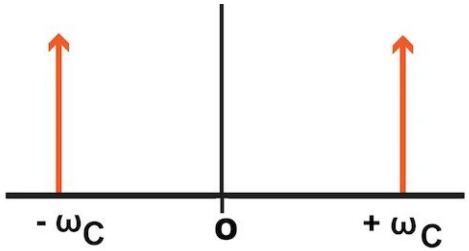


Demodulación AM: En frecuencia

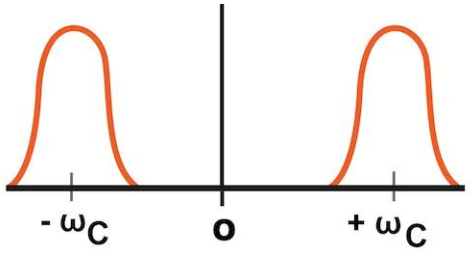
$x(t)$



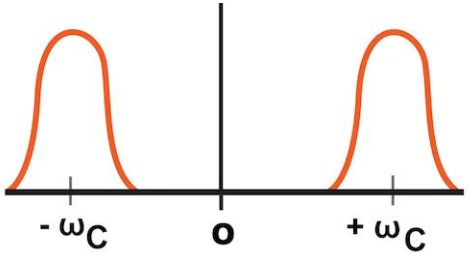
$\cos(2\pi f_c t)$



$s(t) = x(t)\cos(2\pi f_c t)$



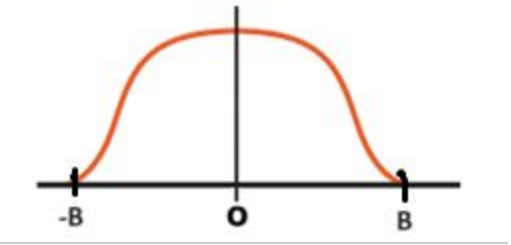
$s(t) = x(t)\cos(2\pi f_c t)$



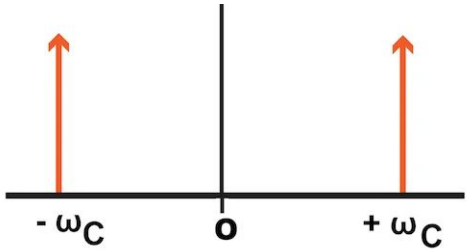
?

Demodulación AM: En frecuencia

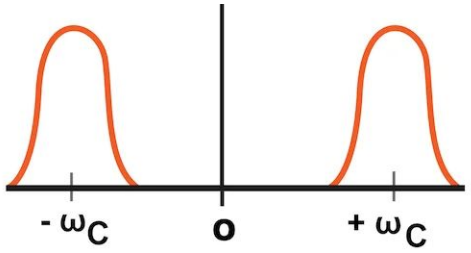
$x(t)$



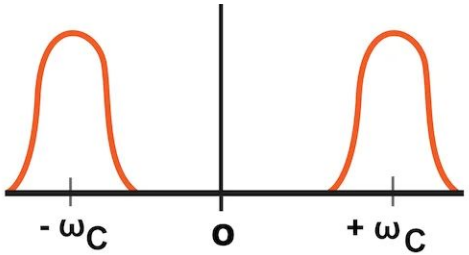
$\cos(2\pi f_c t)$



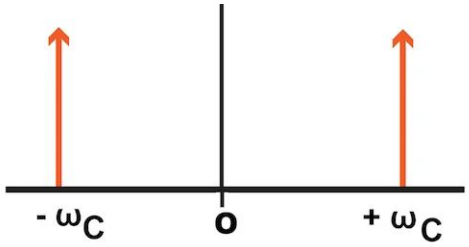
$s(t) = x(t)\cos(2\pi f_c t)$



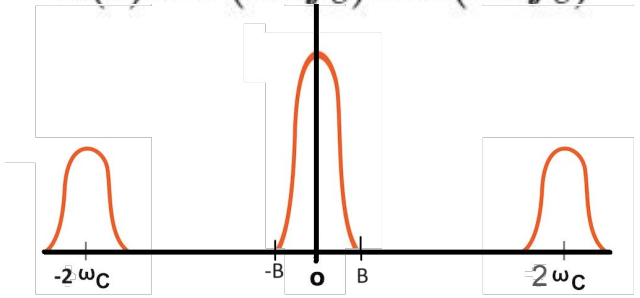
$s(t) = x(t)\cos(2\pi f_c t)$



$\cos(2\pi f_c t)$

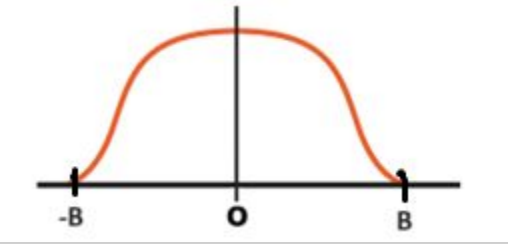


$x(t)\cos(2\pi f_c)\cos(2\pi f_c)$

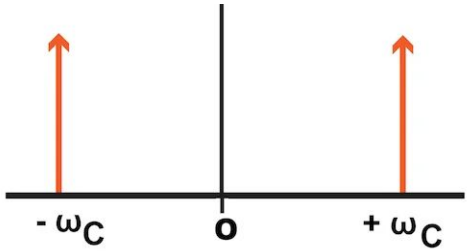


Demodulación AM: En frecuencia

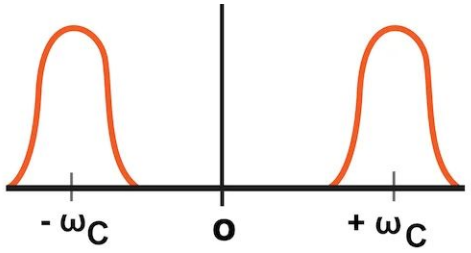
$x(t)$



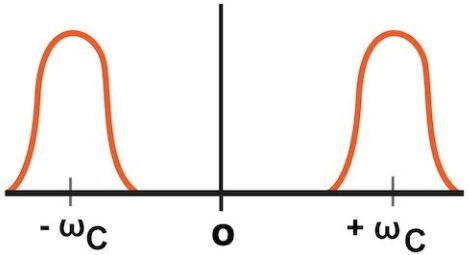
$\cos(2\pi f_c t)$



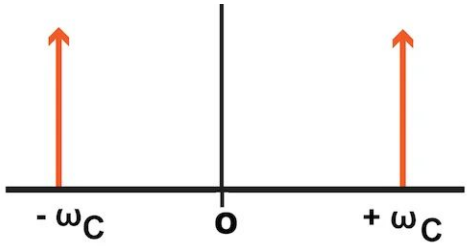
$s(t) = x(t)\cos(2\pi f_c t)$



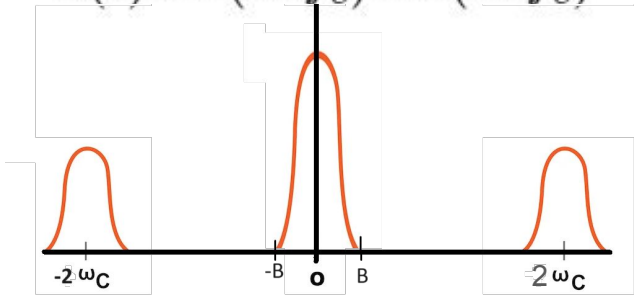
$s(t) = x(t)\cos(2\pi f_c t)$



$\cos(2\pi f_c t)$

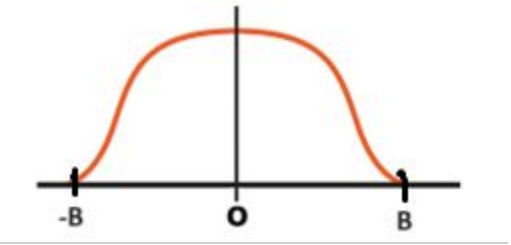


$x(t)\cos(2\pi f_c)\cos(2\pi f_c)$

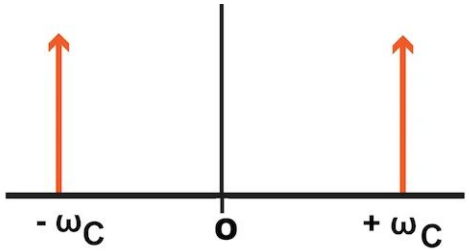


Demodulación AM: En frecuencia

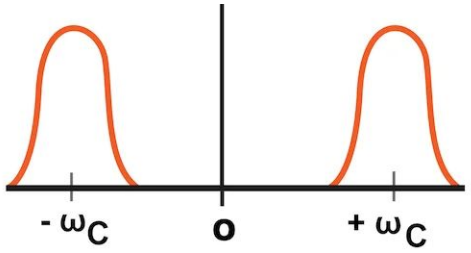
$x(t)$



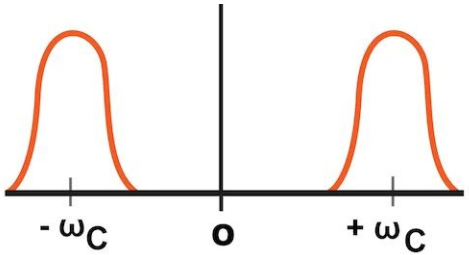
$\cos(2\pi f_c t)$



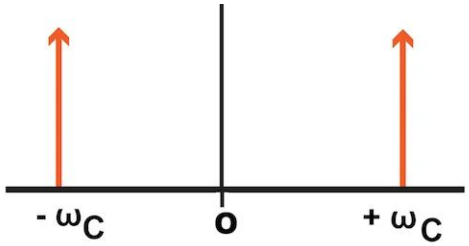
$s(t) = x(t)\cos(2\pi f_c t)$



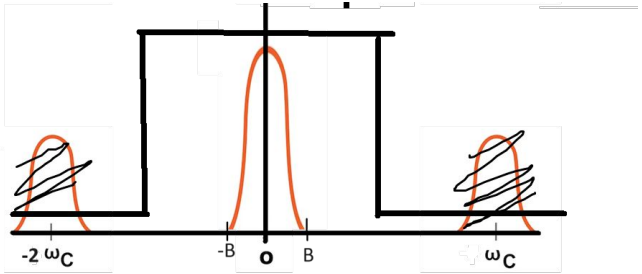
$s(t) = x(t)\cos(2\pi f_c t)$



$\cos(2\pi f_c t)$

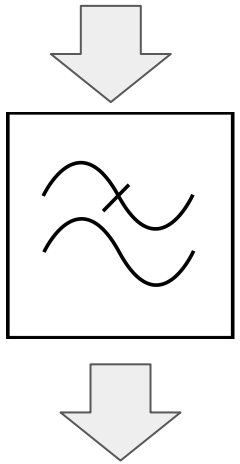


$x(t)$



Demodulación AM: En las Matemáticas

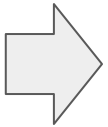
$$s(t)\cos(2\pi f_c) = x(t)\cos(2\pi f_c)\cos(2\pi f_c) = x(t)\tfrac{1}{2}(1+\cos(4\pi f_c))$$



(y multiplicando por 2)

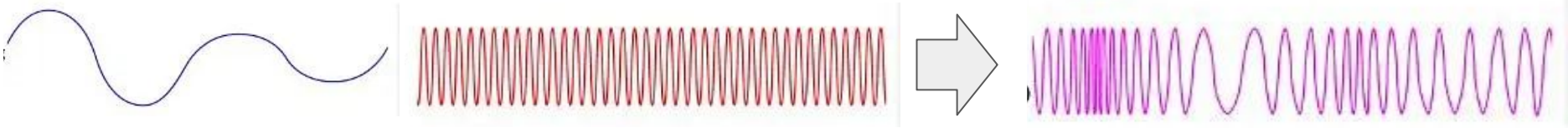
$x(t)$

Modulación FM

$x(t)$ $A\cos(2\pi f_c t)$  $s(t) = A\cos(2\pi f_c + \int_0^t x(T)dT)$

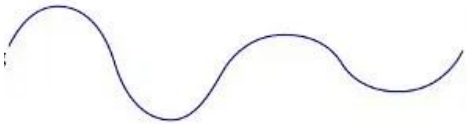
Modulación FM

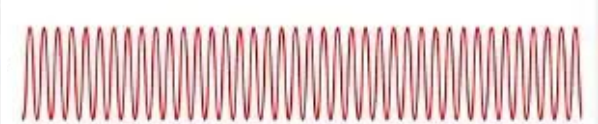
$x(t)$ $A\cos(2\pi f_c t)$ $s(t) = A\cos(2\pi f_c + \int_0^t x(T)dT)$

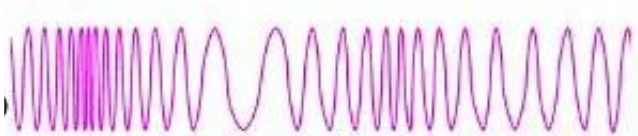


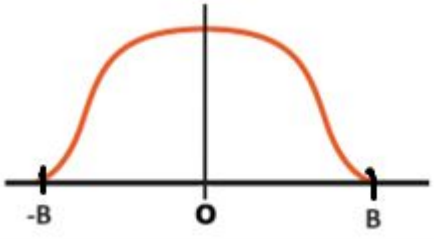
Modulación FM

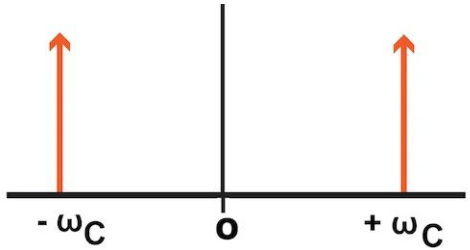
$x(t)$ $A\cos(2\pi f_c t)$ $s(t) = A\cos(2\pi f_c + \int_0^t x(T)dT)$

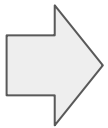












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Demodulación FM

Demodulación FM

El Parcial!

¿Cómo seguimos?

Vamos a trabajar con el Notebook del parcial:

- La parte **uno** consiste en Modulacion AM. Explorar como se ve en el tiempo y en la frecuencia

- La parte **dos** consiste en el teorema de muestreo, tema importante al trabajar con señales digitales

- La parte **tres** consiste en trabajar en la modulación FM, armando un demodulador FM. Es imprescindible tener el demodulador funcionando para poder aprobar el parcial

- Por último en la parte cuatro, trabajaremos con el SDR (receptor), explorando el espectro y obteniendo señales. Clase que viene otra presentación sobre el uso de SDR.

Entregas!

- Entrega intermedia OBLIGATORIA el **miércoles 24 de abril 23:59** hs (ejercicios 3 y 4 de la parte 3)

- Entrega FINAL del parcial (código con demodulador andando en formato .ipynb, señales capturadas por ustedes en archivos .wav e informe con introducción, análisis, conclusiones, etc en formato pdf) para el **domingo 12 de mayo 23:59 hs**