

SL) i)  $m(t) = \cos 1000t$

ii)  $m(t) = 2\cos 1000t + \cos 2000t$

iii)  $m(t) = \cos 1000t, \cos 3000t$

b) i)  $p_{DSB-SC}(t) = m(t) \cdot \overset{\text{carrier}}{\cos 10000t}$

$$= \cos 1000t \cdot \cos 10000t \quad \nearrow \cos A \cdot \cos B = \frac{1}{2} [\cos(A+B) + \cos(A-B)]$$

$$= \frac{1}{2} [\underbrace{\cos 9000t}_{\text{LSB}} + \underbrace{\cos 11000t}_{\text{USB}}]$$

ii)  $p_{DSB-SC}(t) = m(t) \cdot \cos 10000t = [2\cos 1000t + \cos 2000t] \cdot \cos 10000t$

$$= \cos 9000t + \cos 11000t + \frac{1}{2} [\cos 8000t + \cos 12000t]$$

$$= \underbrace{[\cos 9000t + \frac{1}{2} \cos 8000t]}_{\text{LSB}} + \underbrace{[\cos 11000t + \frac{1}{2} \cos 12000t]}_{\text{USB}}$$

iii)  $p_{DSB-SC}(t) = m(t) \cdot \cos 10000t = [\cos 1000t, \cos 3000t] \cdot \cos 10000t$

$$= \frac{1}{2} [\cos 2000t + \cos 6000t] \cdot \cos 10000t$$

$$= \frac{1}{4} [\cos 8000t + \cos 12000t] + \frac{1}{4} [\cos 6000t + \cos 14000t]$$

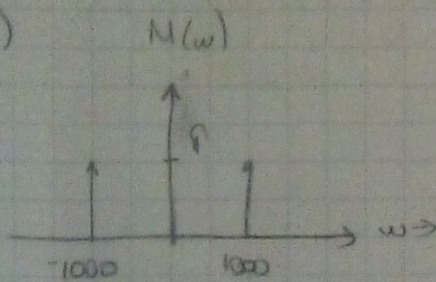
$$= \frac{1}{4} \underbrace{[\cos 6000t + \cos 8000t]}_{\text{LSB}} + \frac{1}{4} \underbrace{[\cos 12000t + \cos 14000t]}_{\text{USB}}$$

$$\cos \omega_0 t \leftrightarrow \pi [\delta(\omega - \omega_0) + \delta(\omega + \omega_0)]$$

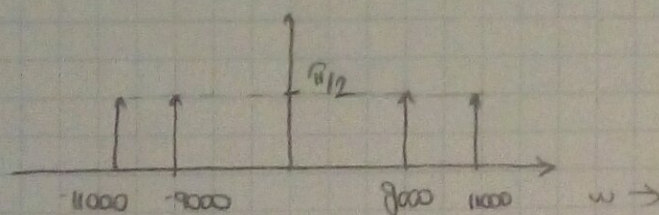


a-b)

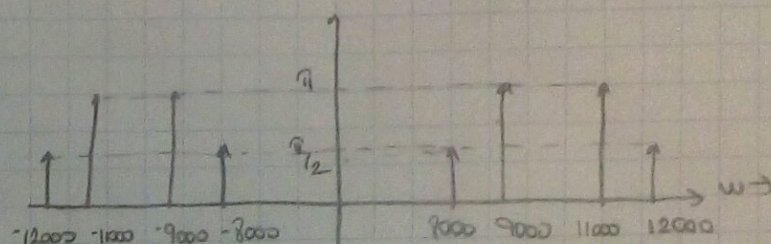
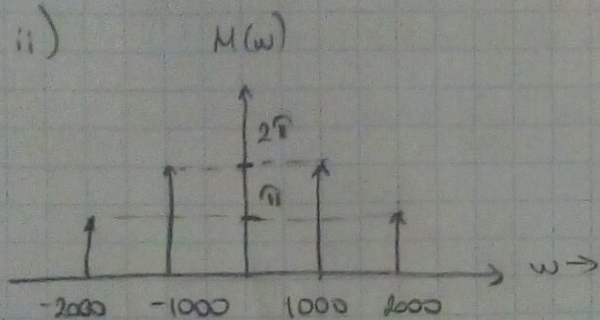
i)



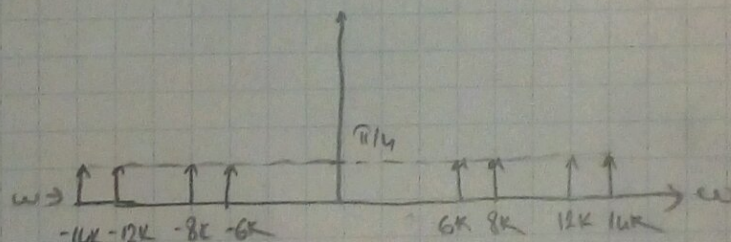
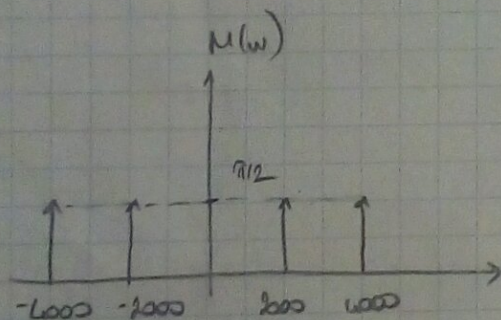
Modulated Signal



ii)



iii)



<u>Signal</u>	<u>Baseband Freq.</u>	<u>DSB Freq.</u>	<u>USB Freq.</u>	<u>LSB Freq.</u>
i)	1000	9000 - 11000	9000	11000
ii)	1000	9000 - 11000	9000	11000
	2000	8000 - 12000	8000	12000
iii)	2000	8000 - 12000	8000	12000
	6000	6000 - 14000	6000	14000



Q2) i)  $m(t) = \sin(100t)$

ii)  $m(t) = e^{-|t|}$

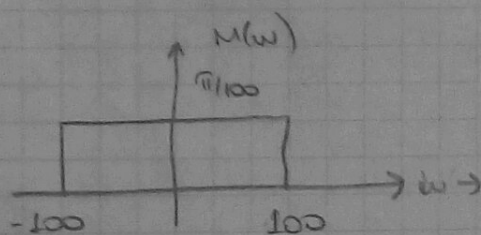
iii)  $m(t) = e^{-|t-1|}$

i)  $M(\omega) = \dots$

Table 3.1  $\rightarrow \frac{W}{\pi} \sin(WT) \longleftrightarrow \text{rect}\left(\frac{\omega}{2W}\right)$

$m(t) = \sin(100t) \rightarrow W = 100$

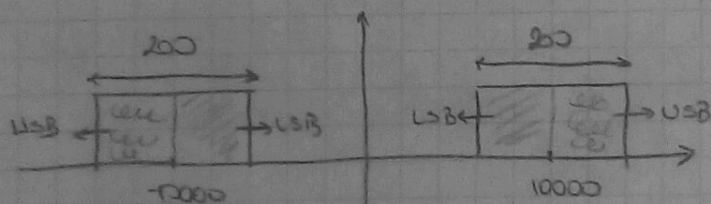
$\sin(100t) \longleftrightarrow \frac{\pi}{100} \cdot \text{rect}\left(\frac{\omega}{200}\right)$



$\varphi_{\text{DSB-SC}}(t) = m(t) \cos(10000t)$

$\rightarrow$  freq. shift.

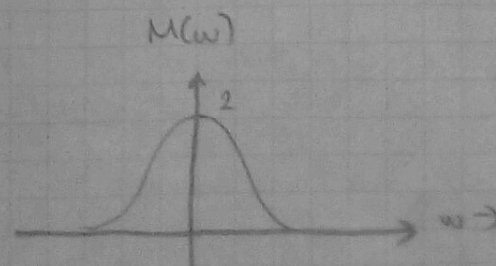
Modulated signal



ii)  $e^{-|t|} \longleftrightarrow M(\omega)$

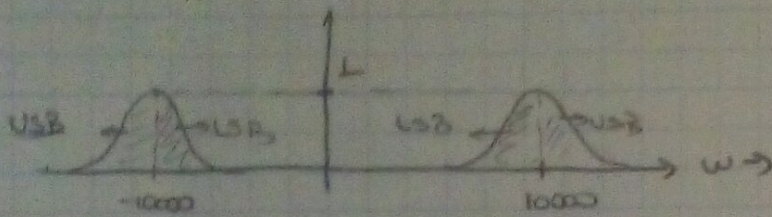
Table 3.1  $\rightarrow e^{-\alpha|t|} \longleftrightarrow \frac{2\alpha}{\alpha^2 + \omega^2}$

$e^{-|t|} \longleftrightarrow \frac{2}{\omega^2 + 1}$

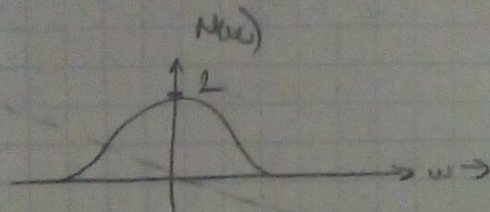




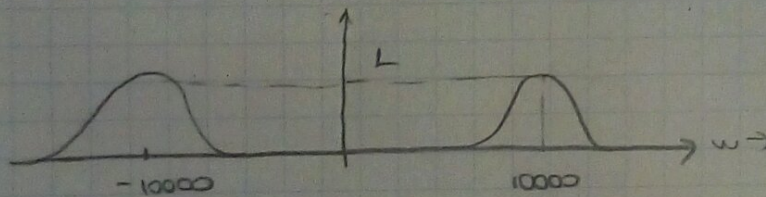
## Modulated Signal



iii)  $e^{-|t-L|} \longleftrightarrow \frac{2}{\omega^2+1} \cdot e^{-j\omega L}$



## Modulated Signal

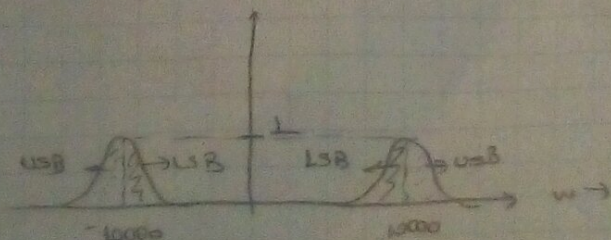
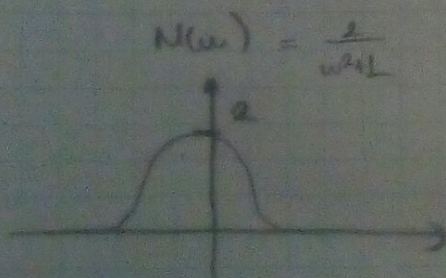


99)  $m(t) = e^{-|t|}$   
 carrier =  $\cos(10000t - \frac{\pi}{4})$

Eq. 3.36  $\rightarrow$

$$g(t) \cdot \cos(\omega_0 t + \theta_0) \longleftrightarrow \frac{1}{2} [G(\omega - \omega_0) e^{j\theta_0} + G(\omega + \omega_0) e^{-j\theta_0}]$$

Modulated signal  $\rightarrow \frac{1}{2} [M(\omega - \omega_0) \cdot e^{-j\frac{\pi}{4}} + M(\omega + \omega_0) \cdot e^{j\frac{\pi}{4}}]$

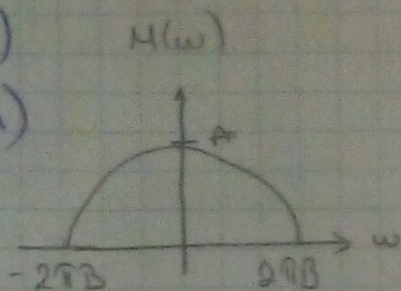


(4)



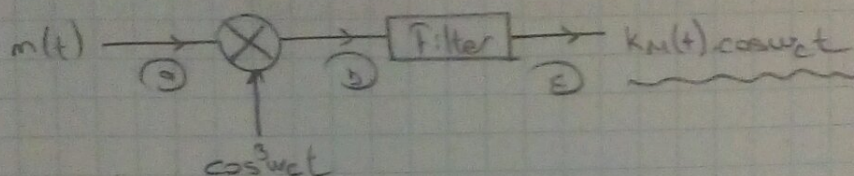
Q4)

a)



(Band-lim. to 3 Hz)

Mod. Sig.  $\rightarrow k_m(t) \cdot \cos \omega_c t$



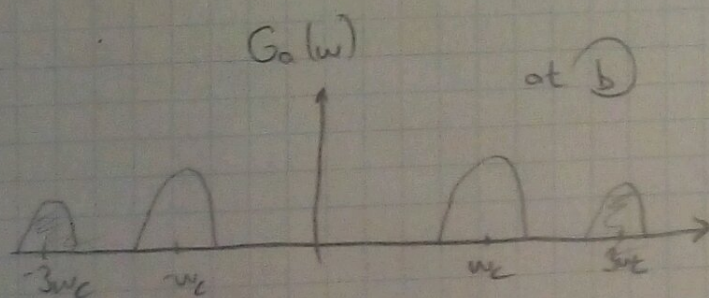
Signal at b  $\rightarrow g_o(t) = M(t) \cdot \cos^3 \omega_c t$

$$= m(t) \cdot \left[ \frac{3}{4} \cos \omega_c t + \frac{1}{4} \cos 3\omega_c t \right]$$

$$= \underbrace{\frac{3}{4} m(t) \cdot \cos \omega_c t + \frac{1}{4} m(t) \cdot \cos 3\omega_c t}_{\text{Desired sig.}}$$

( $k_m(t) \cdot \cos \omega_c t$ )

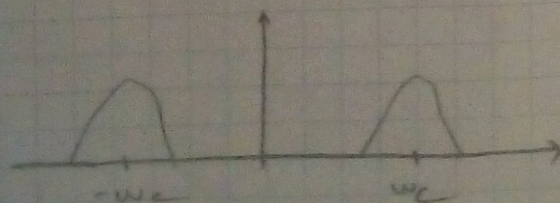
b)



at b)

at c)

} Bandpass filter  
centered at  $\pm \omega_c$ .





c)  $\omega_c = 2\pi B$  to avoid spectral folding at DC.

$$\begin{aligned} \text{d) } m(t) \cdot \cos^2 \omega_c t &= \frac{m(t)}{2} [1 + \cos 2\omega_c t] \\ &= \underbrace{\frac{m(t)}{2}} + \underbrace{\frac{1}{2} m(t) \cos 2\omega_c t} \end{aligned}$$

Baseband s.

Car. freq. =  $2\omega_c$