Cairo University
Faculty of Engineering
Electronics & Communication
Department.

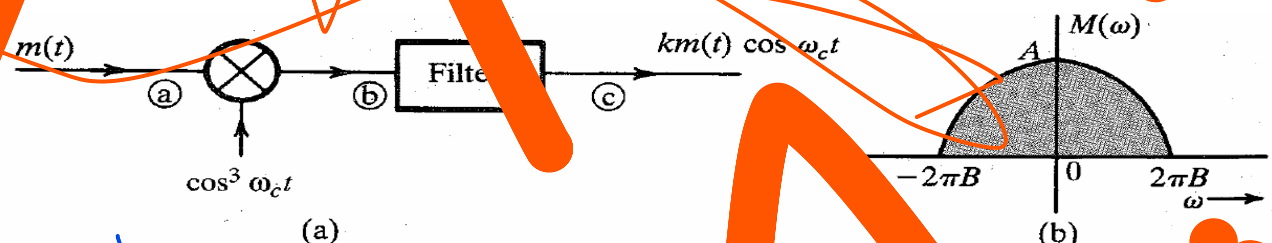
Sheet 2

1-For each of the following baseband signals: (i) $m(t) = \cos 1000t$; (ii) $m(t) = 2\cos 1000t + \cos 2000t$; (iii) $m(t) = \cos 1000t \cos 3000t$:

a) Sketch the spectrum of $m(t)$
b) Sketch the spectrum of the DSB-SC signal $m(t)\cos 10000t$.
c) Identify the upper sideband (USB) and the lower sideband (LSB) spectra.
d) Identify the frequencies in the baseband, and the corresponding frequencies in the DSB-SC USB, and LSB spectra. Explain the nature of frequency shifting in each case.

2-You are asked to design a DSB-SC modulator to generate a modulated signal $km(t)\cos \omega_c t$, where m(t) is a signal band limited to B Hz. The figure shows an available DSB-SC modulator. The carrier generator available generates not $\cos \omega_c t$, but $\cos^3 \omega_c t$. Explain whether you would be able to generate the desired signal using only this equipment. You may use any kind of filter you like.

a) What kind of filter is required?
b) Determine the signal spectra at points b and c, and indicate the frequency bands occupied by these spectra.
c) What is the minimum usable value of ω_c?
d) Would this scheme work if the carrier generator output were $\cos^2 \omega_c t$? Explain.
e) Would this scheme work if the carrier generator output were $\cos^n \omega_c t$ for any integer $n \geq 2$?



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eb2a etfrg 3la 7lha tany ... an enta mko... mrkz -> sec2 video

3- An AM (DSB-LC) transmitter develops an unmodulated power output of one KW across a 50 Ω resistive load. When a sinusoidal test tone with a peak amplitude of 5.0 V is applied to the input of the modulator, it is found that the spectral line for each sideband in the magnitude spectrum for the output is 40% of the carrier line. Determine the following quantities in the output signal:

a) The modulation index
b) The peak amplitude of the lower sideband.
c) The ratio of total sideband power to carrier power.
d) The total power output.
e) The total average power in the output if the peak amplitude of the modulation sinusoid is reduced to 4.0 V.

4- Consider the two amplitude-modulated signals, where $\omega_c >> \omega_m$,

$$\Phi_1(t) = (2 + E_1 \cos \omega_m t) \cos \omega_c t$$
$$\Phi_1(t) = E_2 \cos \omega_m t \ \cos \omega_c t$$

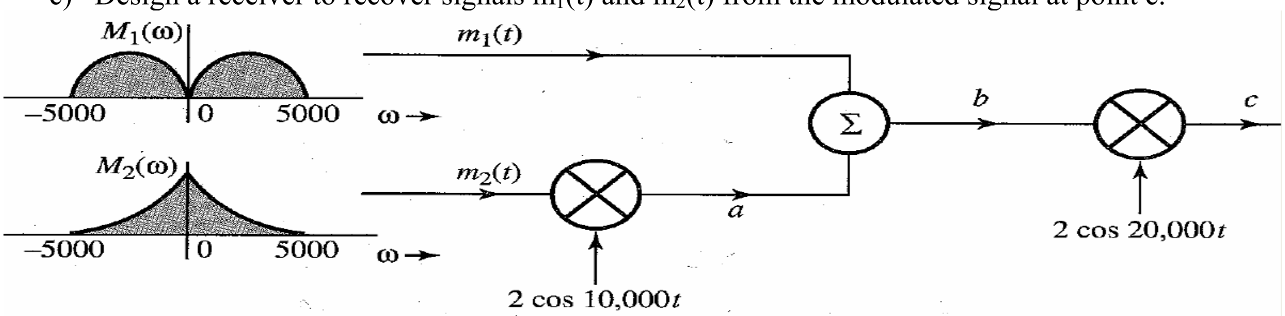
a) Sketch the spectral density of each signal.
b) Determine the required numerical values of E_1 and E_2, to produce 100% modulation in the large carrier signal and the same average power in both signals.
c) Find the ratio of the respective outputs when these signals are applied to a synchronous detector.

5- A given DSB-SC broadcast [illegible] ulation. [illegible]

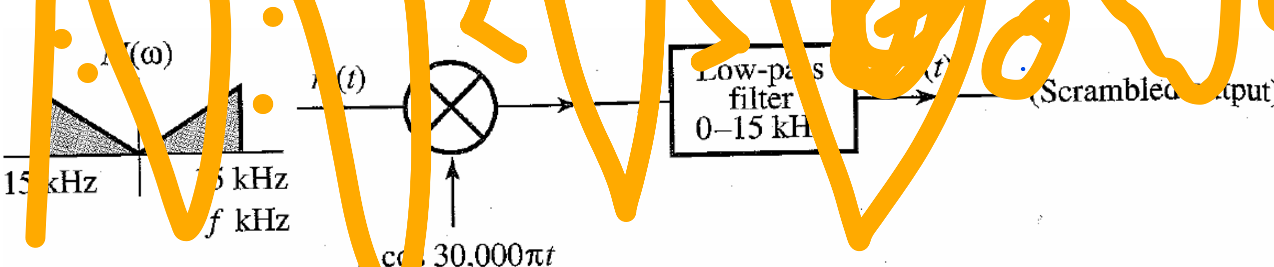
c) T[illegible] the carri[illegible] ed by [illegible] m resisti[illegible]
d) [illegible] plit[illegible] of [illegible] is re[illegible] until [illegible] at t[illegible] remained constant, [illegible] ompute t[illegible] w modula[illegible] ind[illegible] ansmi[illegible] iency.

6-Two signals $m_1(t)$ and $m_2(t)$, both band limited to 5000 rad/s, are to be transmitted simultaneously over a channel by the multiplexing scheme shown in the figure. The signal at point b is the multiplexed signal, which now modulates a carrier of frequency 20000 rad/s. The modulated signal at point c is transmitted.

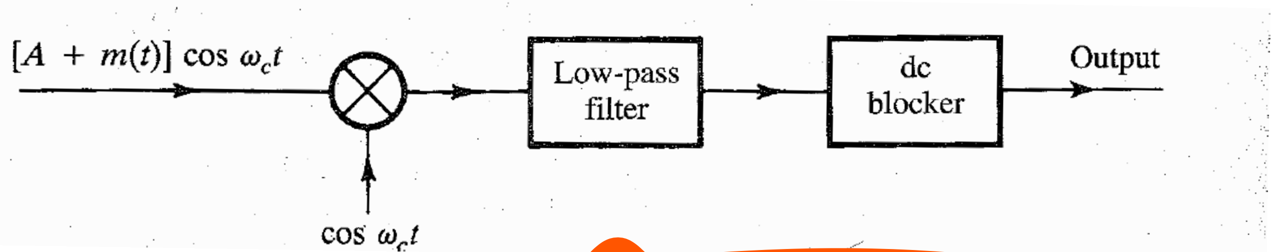
a) Sketch signal spectra at points a, b, and c.
b) What must be the bandwidth of the channel?
c) Design a receiver to recover signals $m_1(t)$ and $m_2(t)$ from the modulated signal at point c.



7- [illegible]ystem shown in figure is used f[illegible] [illegible]mbling audi[illegible] sig[illegible]ls. The output $y(t)$ [illegible] sc[illegible]mbled version [illegible] the [illegible]put signal [illegible]
a) [illegible] the spect[illegible]um [illegible] the scram[illegible]bled signa[illegible] y(t)
b) [illegible]ug[illegible]est a met[illegible]od of [illegible]escramb[illegible]ng th[illegible] sig[illegible]al y(t) t[illegible] obtain m[illegible]t)



8-The figure shows a scheme for coherent demodulation. Show that this scheme can demodulate the AM signal $[A+m(t)]\cos\omega_c t$ regardless of the value of A.



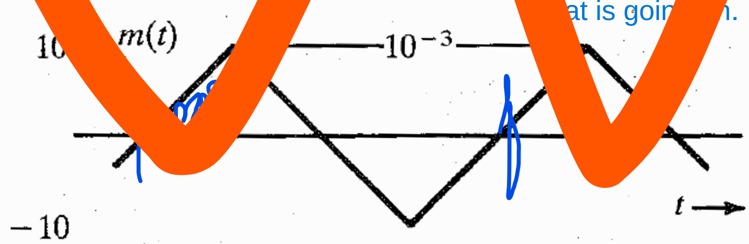
9-Sketch [illegible] AM sign[illegible] corresp[illegible] t[illegible]odulation index: a) μ=0[illegible]) μ=[illegible]) μ=2; d) μ=∞. How d[illegible]ou interpr[illegible] μ=∞.

For th[illegible]M sign[illegible]ith μ=0.8:

a) [illegible]ind the am[illegible]ude and [illegible]e power o[illegible] carrier.

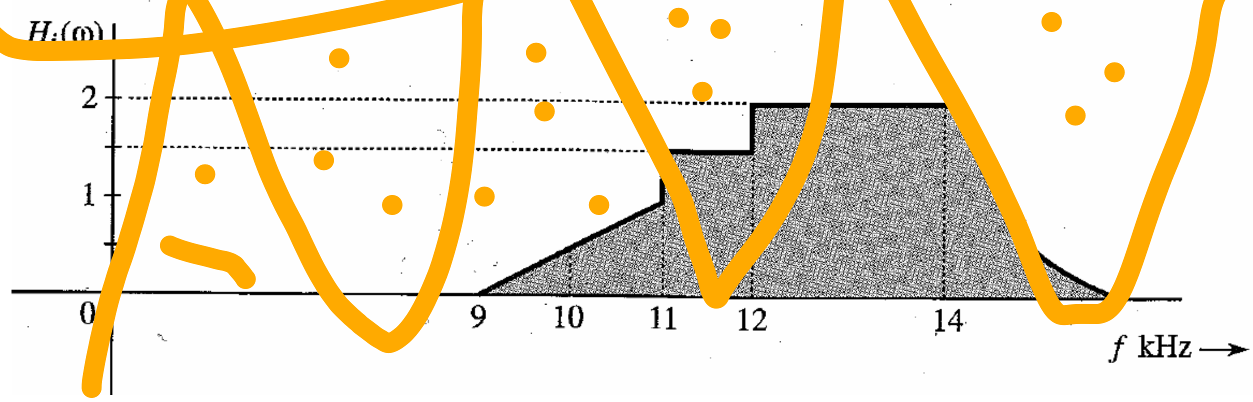
b) Find the side[illegible]d power and the p[illegible]er efficiency η.

[illegible]dvice: solve [illegible] same 2 [illegible]stions for [illegible]lues of u [illegible] [illegible]nsure that y[illegible] unders[illegible]d [illegible]at is goin[illegible]n.



10-In th[illegible] early days of radio, AM signal[illegible] were d[illegible]modulated by a crystal dete[illegible]tor fo[illegible]wed by a low-pass filter [illegible]nd a dc blocker, as shown in the [illegible]gure. Assu[illegible]e a crystal detector to b[illegible] basically a [illegible]uaring devi[illegible]. Determin[illegible] the signal[illegible] points a, b, c, [illegible]nd d. Point ou[illegible] the distortion term in [illegible]he output $y(t)$. Sh[illegible]w [illegible]at if $A \gg |m(t)|$, th[illegible] distortion is small.

11-A vestigial filter $H_1(\omega)$ used in the tra[illegible]mitter has a [illegible]nsfer func[illegible]n as shown in figure. The carrier frequency f_c=10 kHz and the baseband [illegible]igna[illegible] b[illegible]width is 4 kHz. F[illegible]d the correspon[illegible] transfer function of th[illegible] equalizer filter $H_o(\omega)$ [illegible] in t[illegible]e receiver.



12- A transmitter transmits an AM signal with a carrier frequency of 1500 kHz. When an inexpensive radio receiver (which has a poor selectivity in its RF-stage band pass filter) is tuned to 1500 kHz, the signal is heard loud and clear. This same signal is also heard (not as strong) at another dial setting. State, with reasons, at what frequency you will hear this station. The IF frequency is 455 kHz.