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"If you can think, you can Achieve"
So start thinking..

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GATE 2024
GATE
प्रचण्ड Batch
Communication System
PROBLEM DISCUSSION FROM
ALL AMPLITUDE MODULATION
ECE

Chapter-1

Analog Communications

In today's lecture we will cover the following Topis :

1. *Problems Discussion from Amplitude Modulation*

Problems Discussion :

[GATE – EC – 2014]

1. Consider sinusoidal modulation in an AM system. Assuming no over modulation, the modulation index (μ) when the maximum and minimum values of the envelope, respectively, are 3 V and 1 V is ---------.

$\mu \leq 1$

$V_{min} = +ve \rightarrow \mu < 1$

$V_{min} = 0 \rightarrow \mu = 1$

$V_{min} = -ve \rightarrow \mu > 1$

$V_{max} = E_{max} = 3$

$V_{min} = E_{min} = 1$

$$\mu = \frac{V_{max} - V_{min}}{V_{max} + V_{min}} = \frac{3-1}{3+1} = \frac{2}{4} = 0.5$$

Problems Discussion :

[GATE – EC1 – 2015]

8. In the system shown in Figure (A), m(t) is a low-pass signal with bandwidth W Hz. The frequency response of the band-pass filter H(f) is shown in Figure (B). If it is desired that the output signal z(t) = 10x(t), the maximum value of W (in Hz) should be strictly less than 350

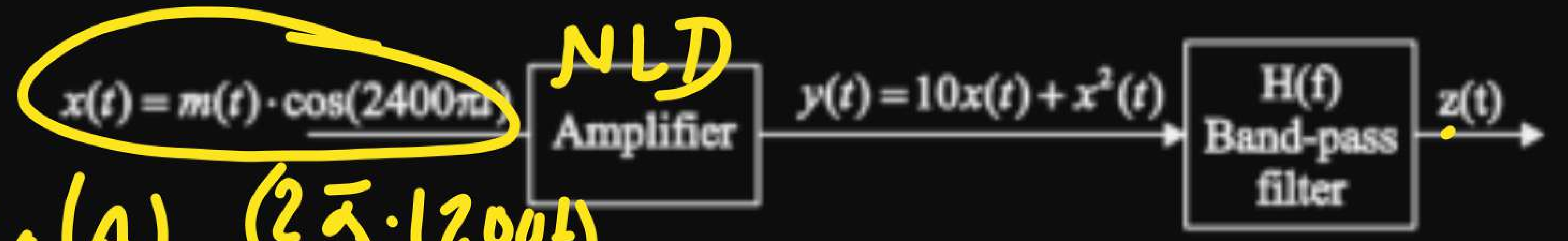


fig (A)

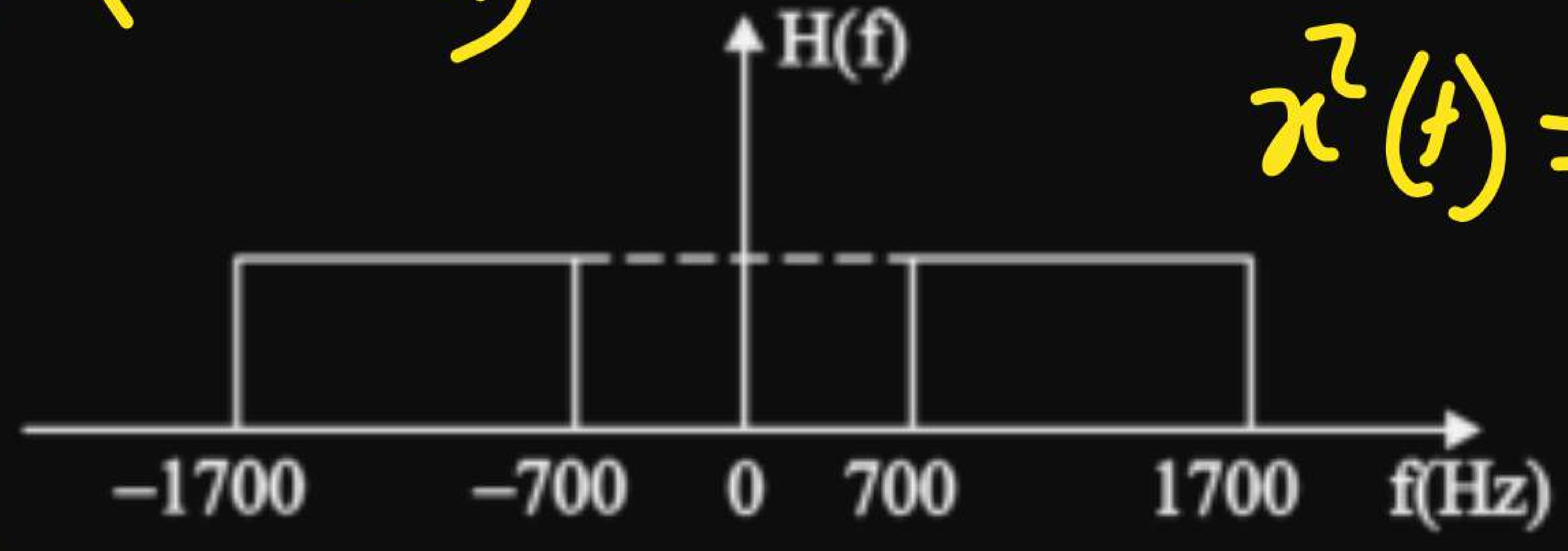
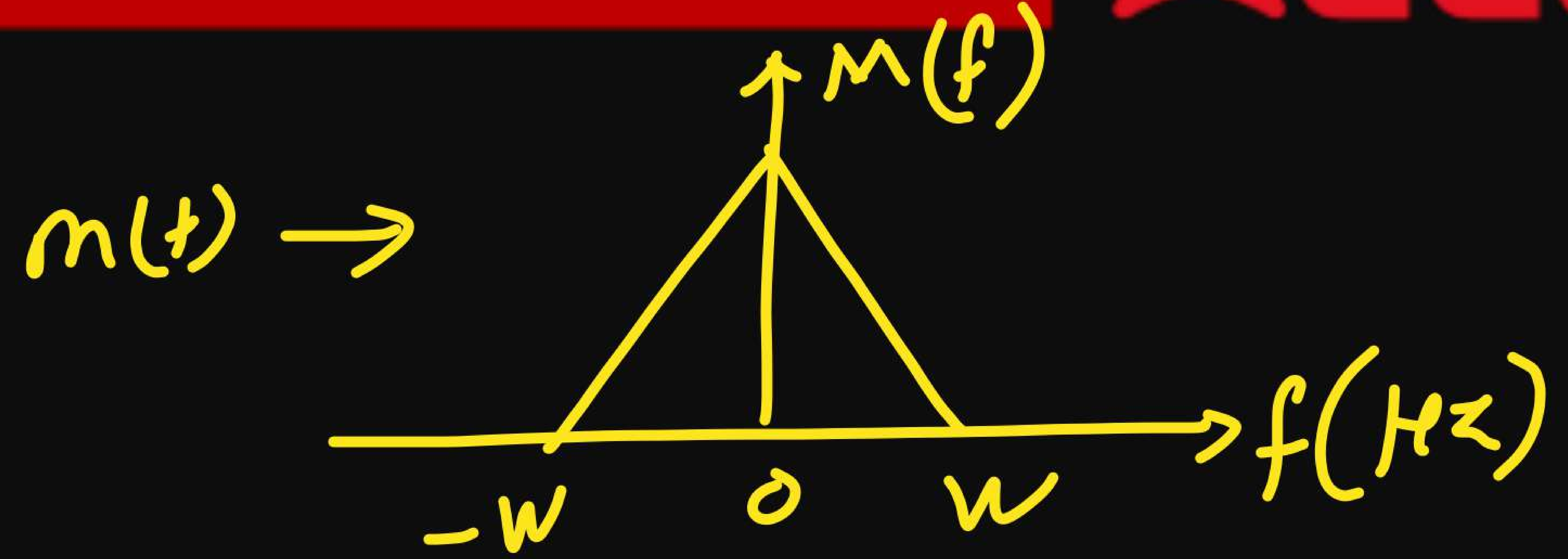
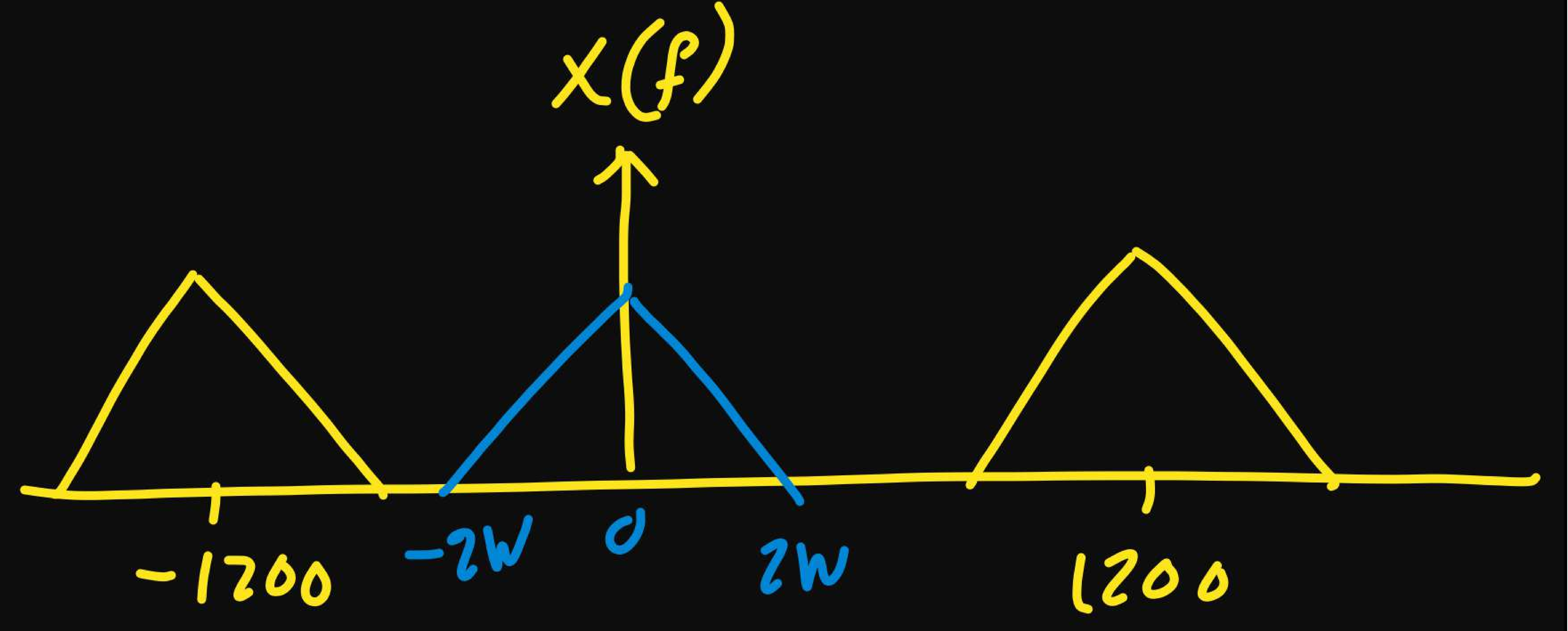


fig (B)





$$x^2(t) = \frac{m^2(t)}{2} + \frac{m^2(t)}{2}\cos 2\pi\cdot 2400t$$

max value of W = 350

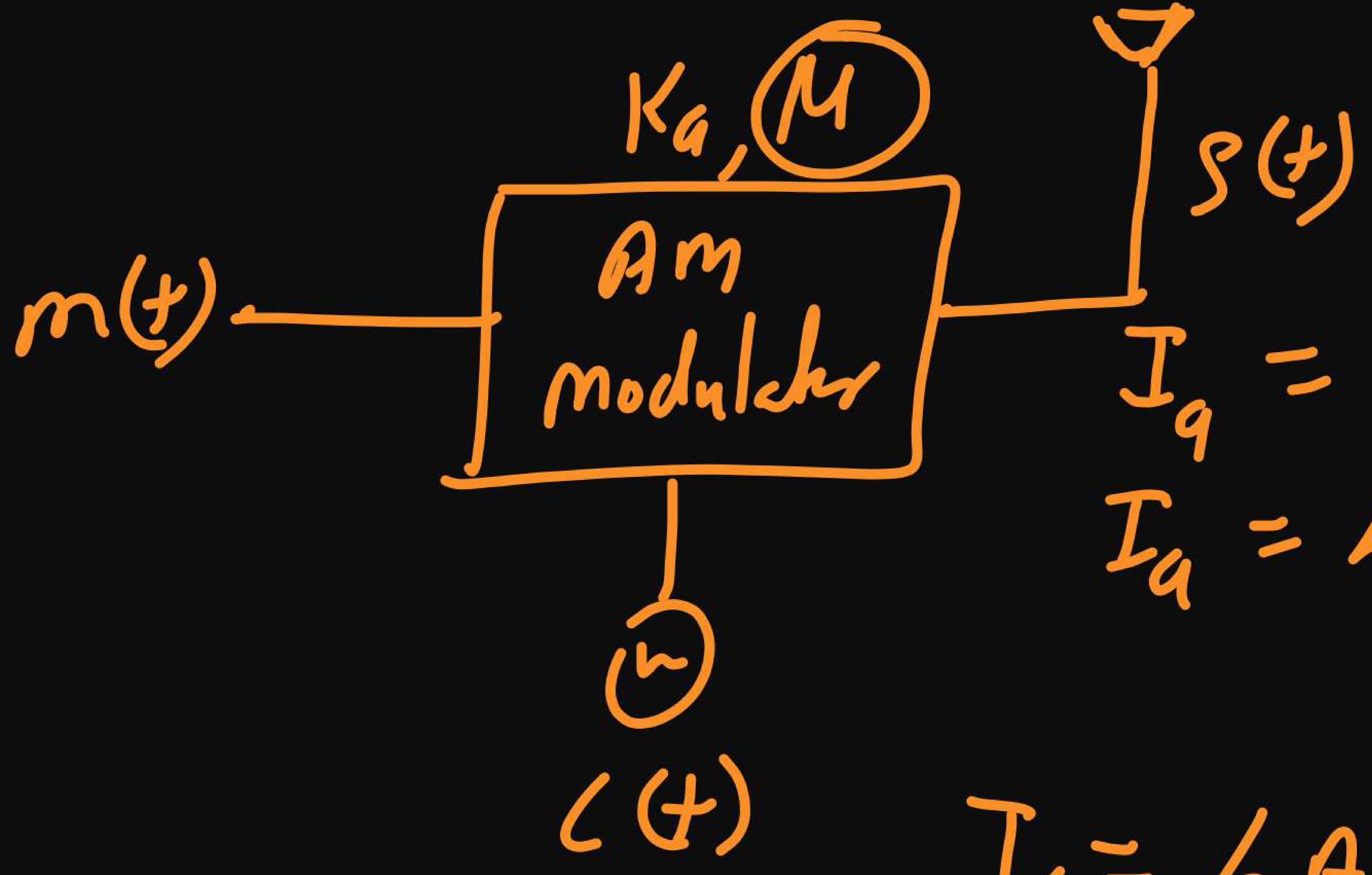
Problems Discussion :

[GATE - IN - 2004]

13. Due to an amplitude modulation by a sine wave, if the total current in the antenna increase from 4A to 4.8 A the depth of modulation in percentage is

(A) 93.8 (B) 80.1

(C) 90.1 (D) 20.2



$I_a = 4A$

$I_a = 4.8A$

$I_c = 4A$

$I_t = 4.8A$

$$P_t = P_c\left[1 + M^2/2\right]$$

$$I_t^2 \cdot R = I_c^2 \cdot R\left[1 + M^2/2\right] \Rightarrow \frac{I_t^2}{I_c^2} = 1 + \frac{M^2}{2} \Rightarrow M = 93.80\,\%$$

Problems Discussion :

[GATE - EC - 2008]

14. Consider the amplitude modulated (AM) signal $A_c \cos \omega_c t + 2\cos \omega_m t \cos \omega_c t$. For demodulating the signal using envelope detector, he minimum value of A_c should be

(A) 2 (B) 1

(C) 0.5 (D) 0

$$s(t) = A_c\left[1 + \frac{2}{A_c}\cos\omega_m t\right]\cos\omega_c t$$

$$\mu = m_a = m = \mu_a = \frac{2}{A_c}$$

$$\mu \le 1$$

$$\frac{2}{A_c} \le 1 \Rightarrow A_c \ge 2$$

$$(A_c)_{min} = 2$$

Problems Discussion :

[GATE - EC - 2010]

16. Suppose that the modulating signal is m(t) = $2\cos(2\pi f_m t)$ and the carrier signal is $x_c(t) = A_c \cos(2\pi f_c t)$. Which one of the following is a conventional AM signal without over – modulation?

(A) $x(t) = A_c m(t)\cos(2\pi f_c t)$ → DSB-SC

(B) $x(t) = A_c[1 + m(t)]\cos(2\pi f_c t)$ → $K_a = 1$

(C) $x(t) = A_c \cos(2\pi f_c t) + \frac{A_c}{4} m(t)\cos(2\pi f_c t)$ → $K_a = 1/4$

(D) $x(t) = A_c \cos(2\pi f_m t)\cos(2\pi f_c t)$
$+ A_c \sin(2\pi f_m t)\cos(2\pi f_c t)$

$\mu \leq 1$

$s(t) = A_c[1 + K_a m(t)]\cos 2\pi f_c t$

$s(t) = A_c[1 + 2K_a \cos 2\pi f_m t]\cos 2\pi f_c t$

$\mu = 2K_a$

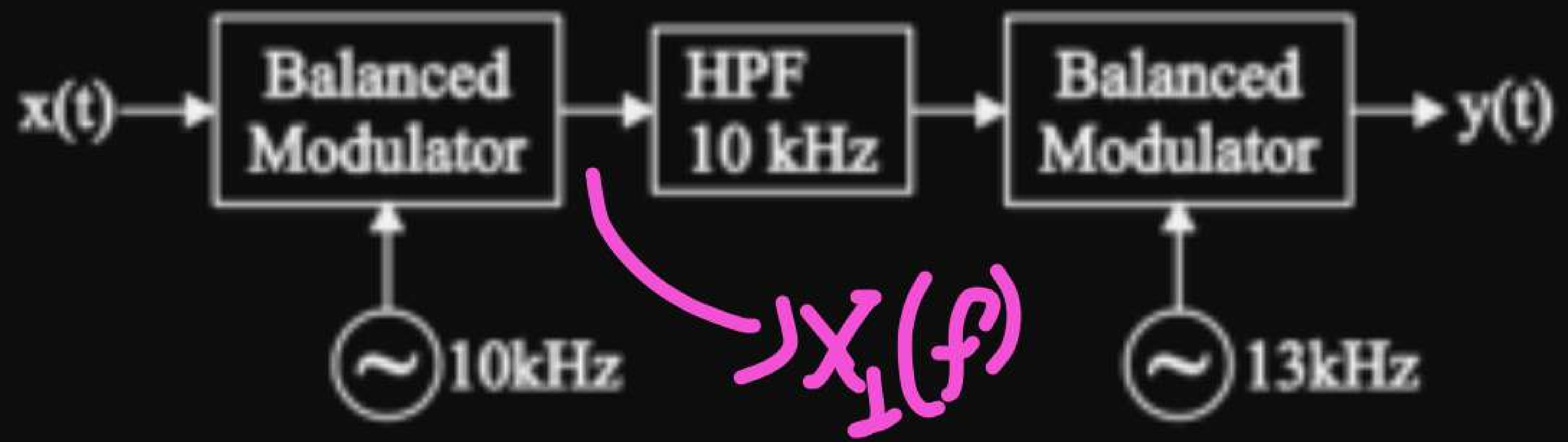
$\mu \leq 1$ $\quad 2K_a \leq 1$

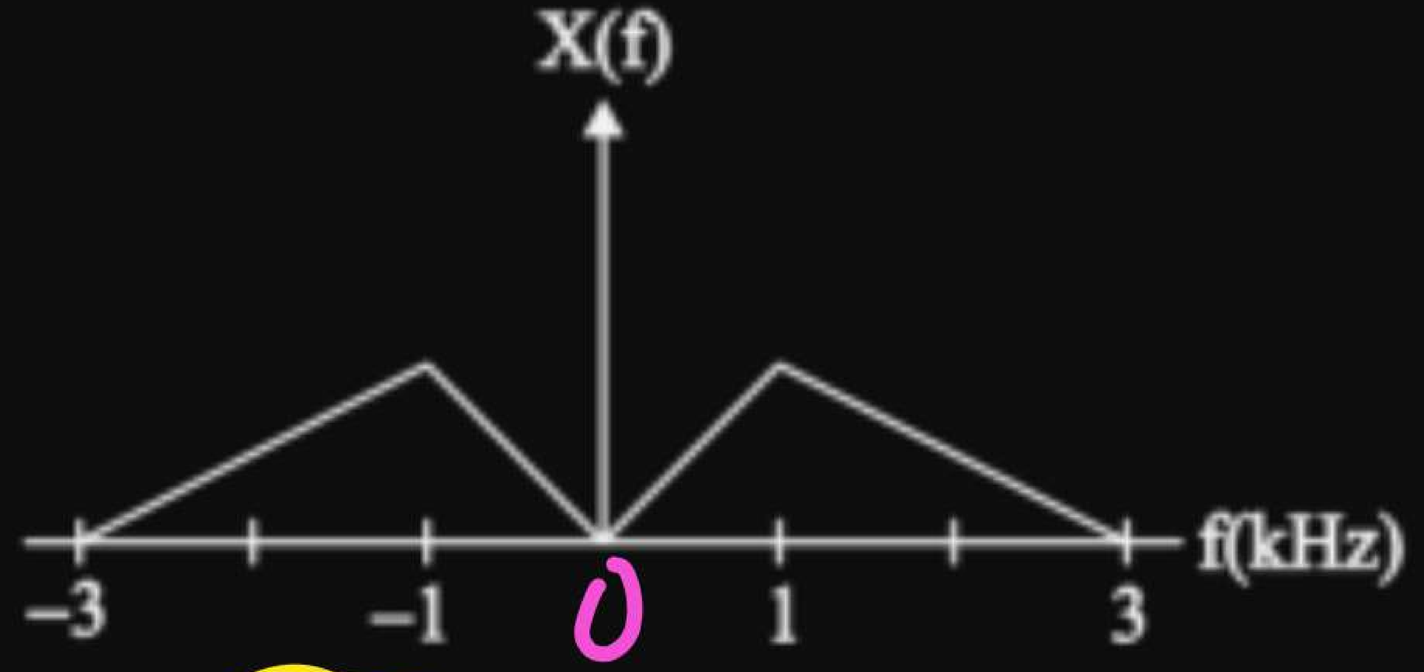
$K_a \leq 1/2$

Problems Discussion :

[GATE - EC - 2004]

33. Consider a system shown in fig. Let X(f) and Y(f) denote the Fourier transforms of x(t) and y(t) respectively. The ideal HPF has the cut-off frequency 10 KHZ.





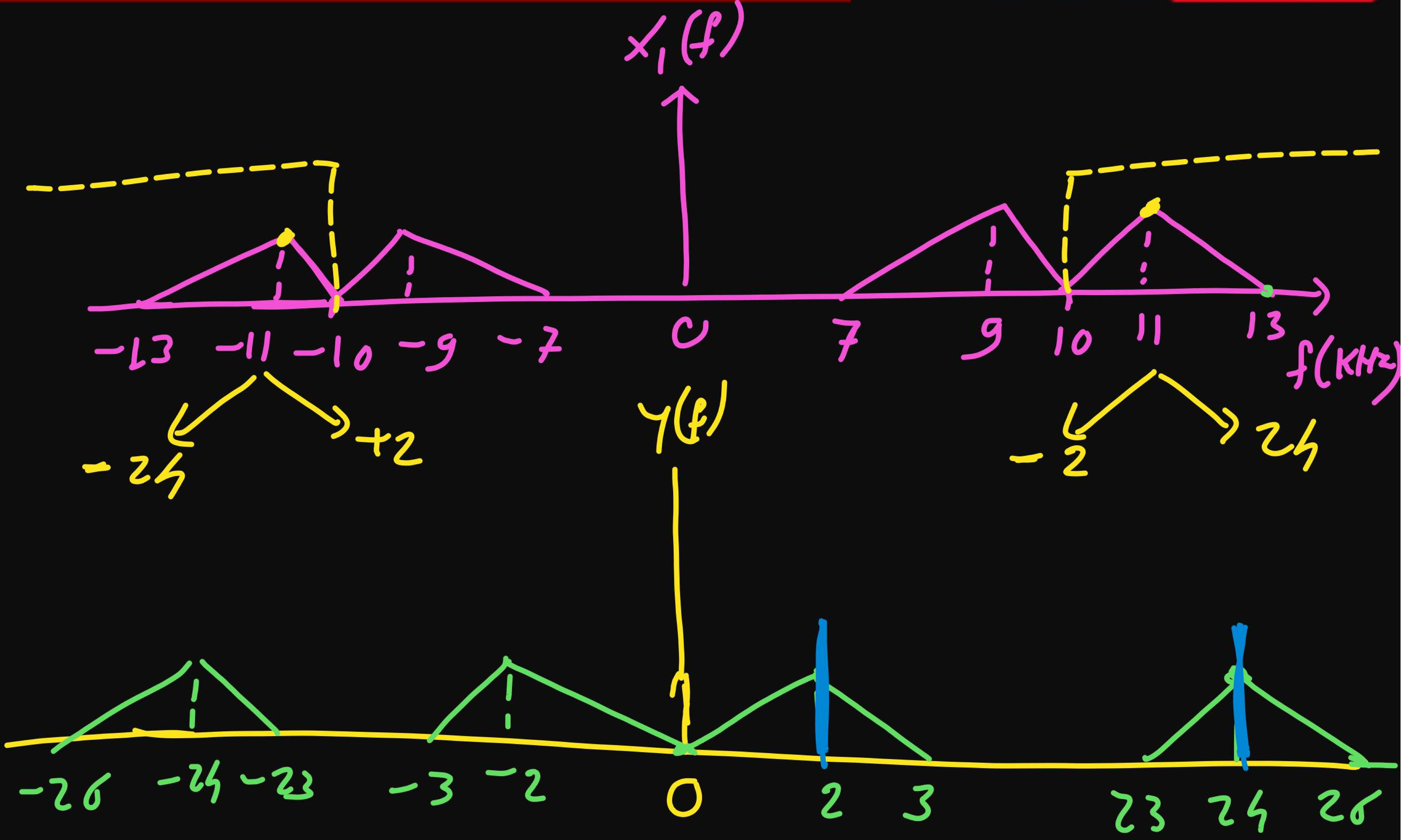
The positive frequencies where Y(f) has spectral peaks are

(A) 1 KHZ and 24 KHZ

(B) 2KHZ and 24KHZ

(C) 1 KHZ and 14 KHZ

(D) 2 KHZ and 14 KHZ



Problems Discussion :

[GATE - EC - 2000]

56. The amplitude modulated wave form s(t) = $A_c[1+K_a m(t)]\cos\omega_c t$ is fed to an ideal envelope detector. The maximum magnitude of $K_a m(t)$ is greater than 1. Which of the following could be the detector output?

(A) $A_c m(t)$

(B) $A_c^2[1+K_a m(t)]^2$

(C) $\left[A_c\left|1+k_a m(t)\right|\right]$

(D) $A_c\left|1+K_a m(t)\right|^2$

$\mu = K_a m(t) > 1$ → over modulated

$s(t) \rightarrow A_c[1+K_a m(t)]\cos 2\pi f_c t$

↓ ED

$\left|A_c[1+K_a m(t)]\right| = A_c\left|(1+K_a m(t))\right|$

Problems Discussion :

[GATE - EC - 2004]

63. An AM signal is detected using an envelope detector. The carrier frequency and modulating signal frequency are 1 MHz and 2 KHz respectively. An appropriate value for the time constant of the envelope detector is

(A) 500 μ sec
(B) 20 μ sec
(C) 0.2 μ sec
(D) 1 μ sec

$f_m = 2\,KHz$, $f_c = 1\,MHz$

$$\frac{1}{f_c} \ll R_L C \ll \frac{1}{f_m}$$

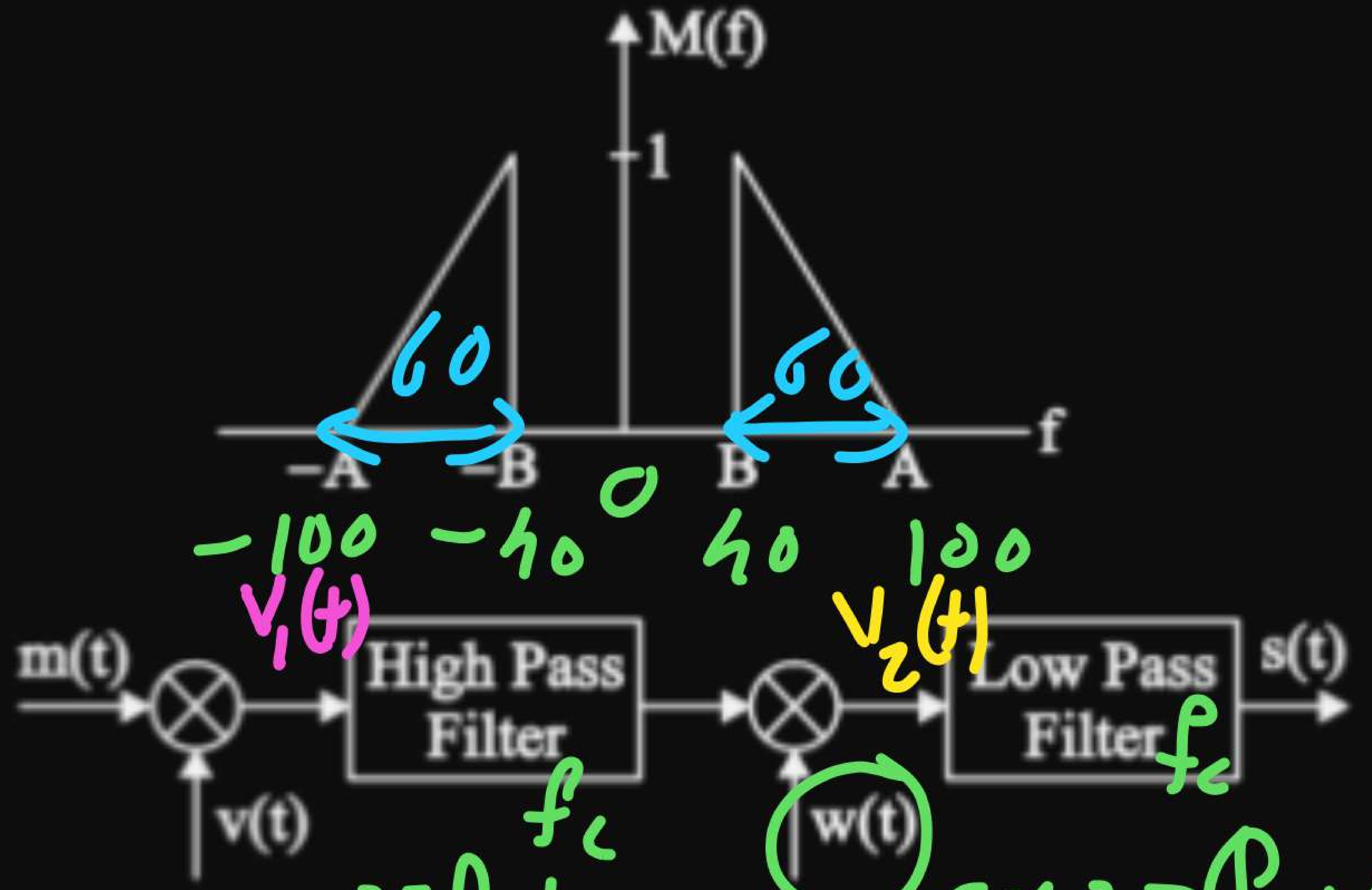
$1\,\mu sec \ll R_L C \ll 0.5\,msec$

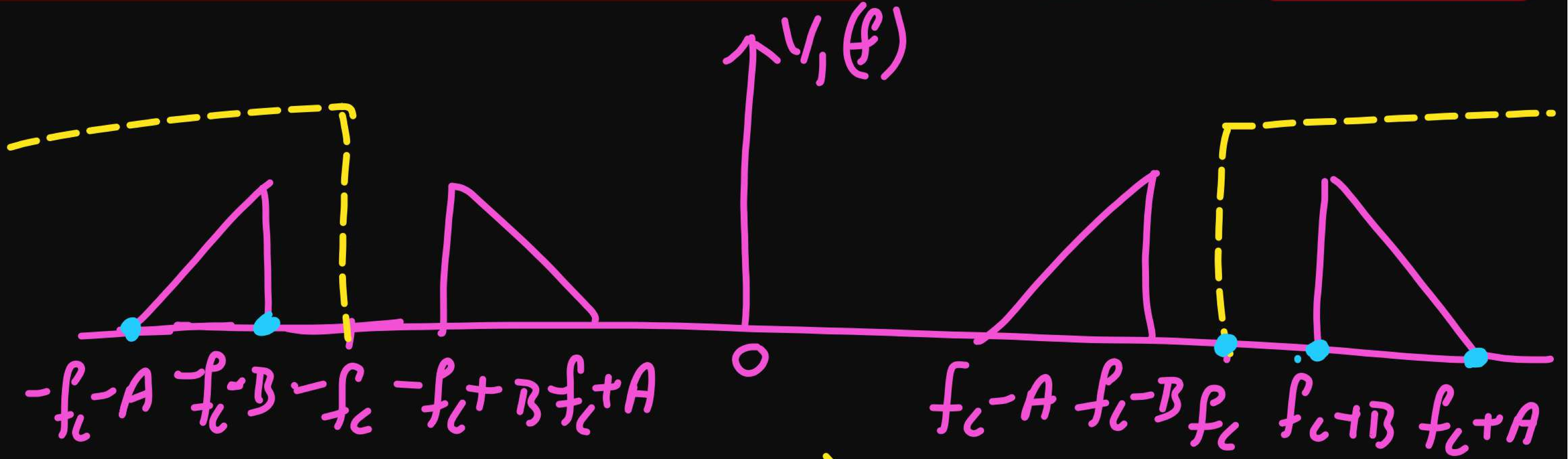
500 μsec

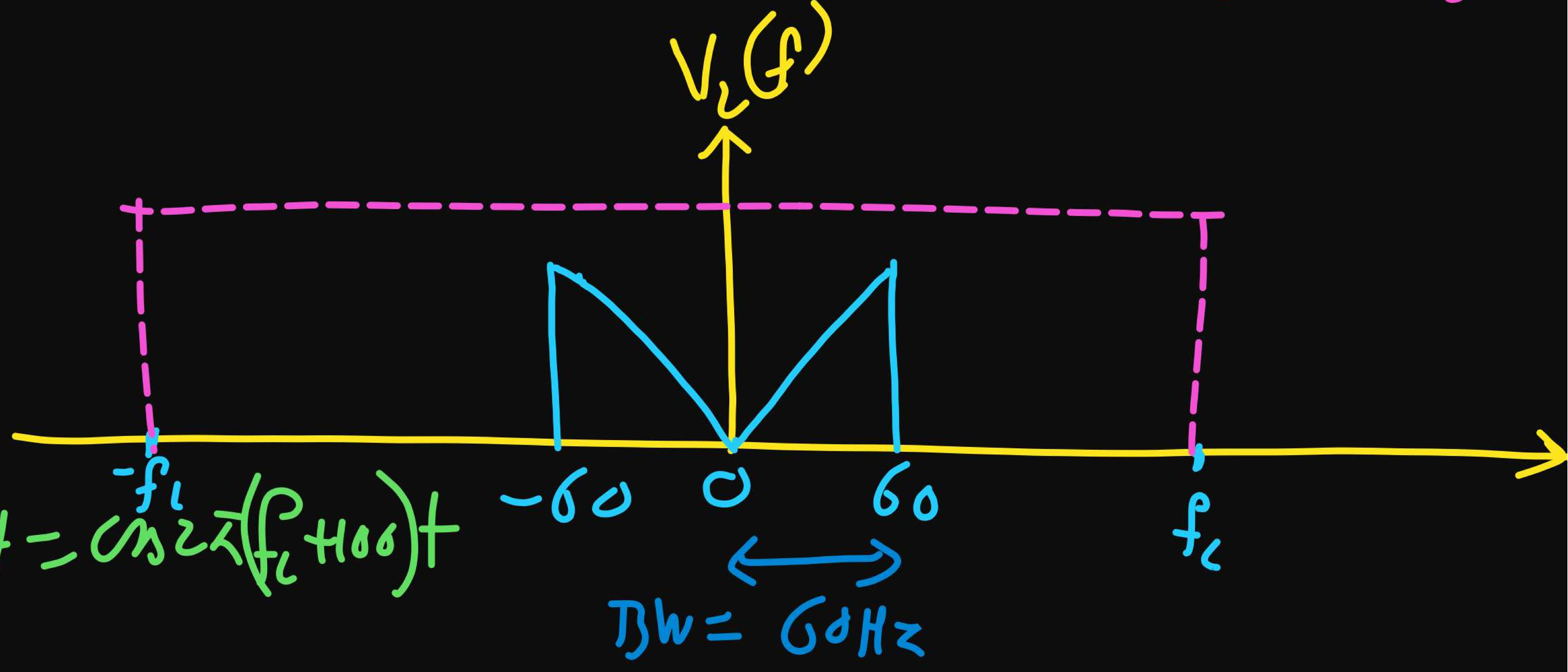
Problems Discussion :

[GATE – EC – 2014]

80. In the figure, M (f) is the Fourier transform of the message signal m (t) where A = 100 Hz and B = 40 Hz. Given v (t) = cos (2 π f_ct) and w (t) = cos (2 π (f_c + A)t), where f_c > A. The cutoff frequencies of both the filters are f_c.







The bandwidth of the signal at the output of the modulator (in Hz) is --------

Problems Discussion :

[GATE - EC - 2009]

111. For a message signal m(t) = $\cos(2\pi f_m t)$ and carrier of frequency f_c, which of the following represents a single side-band (SSB) signal?

(A) $\cos(2\pi f_m t)\cos(2\pi f_c t)$ → DSB-SC

(B) $\cos(2\pi f_c t)$ → only carrier

(C) $\cos[2\pi(f_c + f_m)t]$ → SSB-SC

(D) $[1+\cos(2\pi f_m t)]\cos(2\pi f_c t)$ → AM

$m(t) = \cos 2\pi f_m t$

$c(t) = A_c \cos 2\pi f_c t$

$s(t)\big|_{SSB} = \frac{A_c}{2} m(t) \cos 2\pi f_c t \mp \frac{A_c}{2} \hat{m}(t) \sin 2\pi f_c t$

$= \frac{A_c}{2} \cos 2\pi f_m t \cos 2\pi f_c t \mp \frac{A_c}{2} \sin 2\pi f_m t \sin 2\pi f_c t$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