DISCRETE

EE23BTECH11006 - Ameen Aazam*

Question : Consider a carrier signal which is amplitude modulated by a single-tone sinusoidal message signal with a modulation index of 50%. If the carrier and one of the sidebands are suppressed in the modulated signal, the percentage of power saved (rounded off to one decimal place) is . . . .

(GATE EC 2021)

Solution: The percentage modulation,

Parameters	Values	Description
m	50%	Percentage modulation
$x_c(t)$		Carrier signal
$f_c(t)$	$1000Hz$	Carrier signal frequency
$x_m(t)$		Message signal
$f_m(t)$	$25Hz$	Message signal frequency
A_c		Amplitude of Carrier signal
P_t		Total power of the modulated AP
P_c	$\frac{A_c^2}{2}$	Power of the carrier signal
P_s		Saved power

TABLE 0
PARAMETERS

$$m = 50\% = 0.5 \tag{1}$$

Suppose, we have the carrier signal as,

$$x_c(t) = A_c \sin(2\pi f_c t) \tag{2}$$

So the message signal,

$$x_m(t) = m A_c \sin(2\pi f_m t) \tag{3}$$

And the modulated signal,

$$y(t) = A_c (1 + m \sin(2\pi f_m t)) \sin(2\pi f_c t) \tag{4}$$

Now the modulated signal in the frequency domain looks like, After the carrier signal and one of the
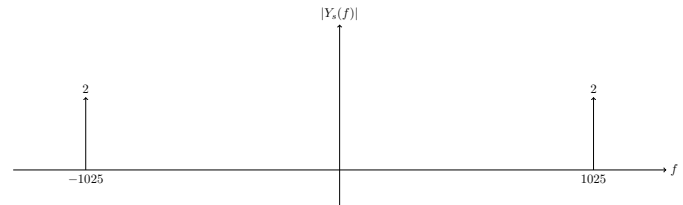

Fig. 0. Modulated Signal

Fig. 0. Suppressed Signal

side bands are removed, The total power is due to the carrier and the two sidebands,

$$P_t = P_c \left[1 + \frac{m^2}{2} \right] \tag{5}$$

Now as the carrier signal and one of the sidebands are suppressed then total saved power,

$$P_s = P_c \left[1 + \frac{m^2}{4} \right] \tag{6}$$

So percentage power saved,

$$= \frac{P_s}{P_t} \times 100\% \tag{7}$$

$$= \frac{P_c \left[1 + \frac{m^2}{4} \right]}{P_c \left[1 + \frac{m^2}{2} \right]} \times 100\% \tag{8}$$

$$= \frac{1 + \frac{1}{16}}{1 + \frac{1}{8}} \times 100\% \tag{9}$$

$$= 94.44\% \tag{10}$$

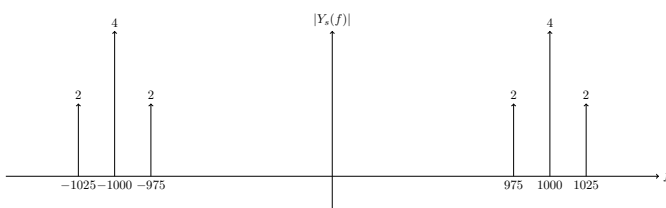Hence, the percentage power saved is 94.4%.