# DISCRETE

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**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,

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

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

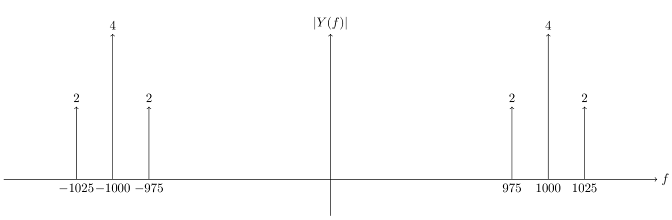


Fig. 0. Modulated Signal

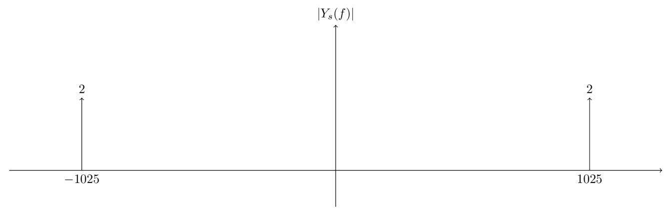


Fig. 0. Suppressed Signal

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%.