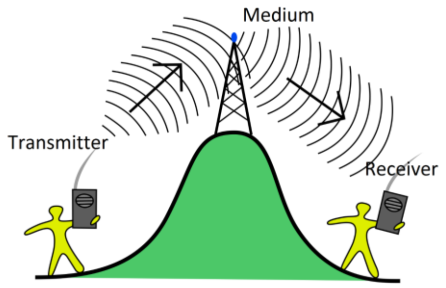
# Chapter 8 Communication Systems




**§8.1 Complex Exponential and Sinusoidal Amplitude Modulation (AM)**

$x(t)$ is the modulating signal.

$c(t)$ is the carrier signal.

$y(t) = x(t)c(t)$ is the modulated signal.

1. Amplitude Modulation with a Complex Exponential Carrier

$c(t) = e^{j\omega_c t}$

$\omega_c$ is called the carrier frequency.

| Modulation | | Demodulation |
|---|---|---|
| $y(t) = x(t)e^{j\omega_c t}$<br>$Y(j\omega) = X[j(\omega - \omega_c)]$ | ⇔ | $r(t) = y(t)e^{-j\omega_c t}$<br>$R(j\omega) = X(j\omega)$ |

2. Amplitude Modulation with a Sinusoidal Carrier

$c(t) = \cos(\omega_c t)$

Modulation

$$y(t) = x(t)\cos(\omega_c t) = x(t)\left\{\frac{1}{2}\left[e^{j\omega_c t} + e^{-j\omega_c t}\right]\right\}$$

$$Y(j\omega) = \frac{1}{2\pi}X(j\omega) * \pi[\delta(\omega - \omega_c) + \delta(\omega + \omega_c)]$$

$$Y(j\omega) = \frac{1}{2}\{X[j(\omega - \omega_c)] + X[j(\omega + \omega_c)]\}$$

2. Amplitude Modulation with a Sinusoidal Carrier

$c(t) = \cos(\omega_c t)$

Synchronous Demodulation

$$r(t) = y(t)\cos(\omega_c t) = y(t)\left\{\frac{1}{2}\left[e^{j\omega_c t} + e^{-j\omega_c t}\right]\right\}$$

$$R(j\omega) = \frac{1}{2}\{Y[j(\omega - \omega_c)] + Y[j(\omega + \omega_c)]\}$$

$$= \frac{1}{2}X(j\omega) + \frac{1}{4}\{X[j(\omega - 2\omega_c)] + X[j(\omega + 2\omega_c)]\}$$

Synchronous Demodulation

$$r(t) = y(t)\cos(\omega_c t) = y(t)\left\{\frac{1}{2}\left[e^{j\omega_c t} + e^{-j\omega_c t}\right]\right\}$$

$$R(j\omega) = \frac{1}{2}\{Y[j(\omega-\omega_c)] + Y[j(\omega+\omega_c)]\}$$

$$= \frac{1}{2}X(j\omega) + \frac{1}{4}\{X[j(\omega-2\omega_c)] + X[j(\omega+2\omega_c)]\}$$

$$r(t) = y(t)\cos(\omega_c t + \emptyset_c)$$
$$= x(t)\cos(\omega_c t + \theta_c)\cos(\omega_c t + \emptyset_c)$$

Influence on the demodulated signal when the modulator and the demodulator are not synchronous in phase:

$$= \frac{1}{2}\cos(\theta_c - \emptyset_c)\, x(t) + \frac{1}{2}x(t)\cos(2\omega_c t + \theta_c + \emptyset_c)$$

$$\hat{x}(t) = r(t) * h(t) = x(t)\cos(\theta_c - \emptyset_c)$$

## Homework

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|---|---|---|---|
| 8.22 | 8.28 | | |
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| 8.1 | 8.3 | | |
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① Do not wait until the last minute
② Express your own idea and original opinion
③ Keep in mind the zero-tolerance policy on plagiarism