Lecture 4

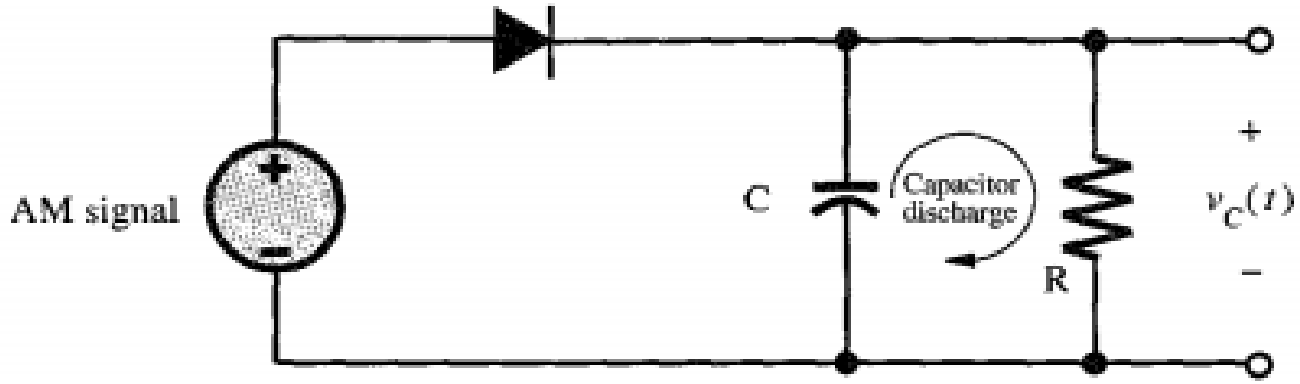
DSB-TC Demodulation

AM Demodulation using an Envelope Detector

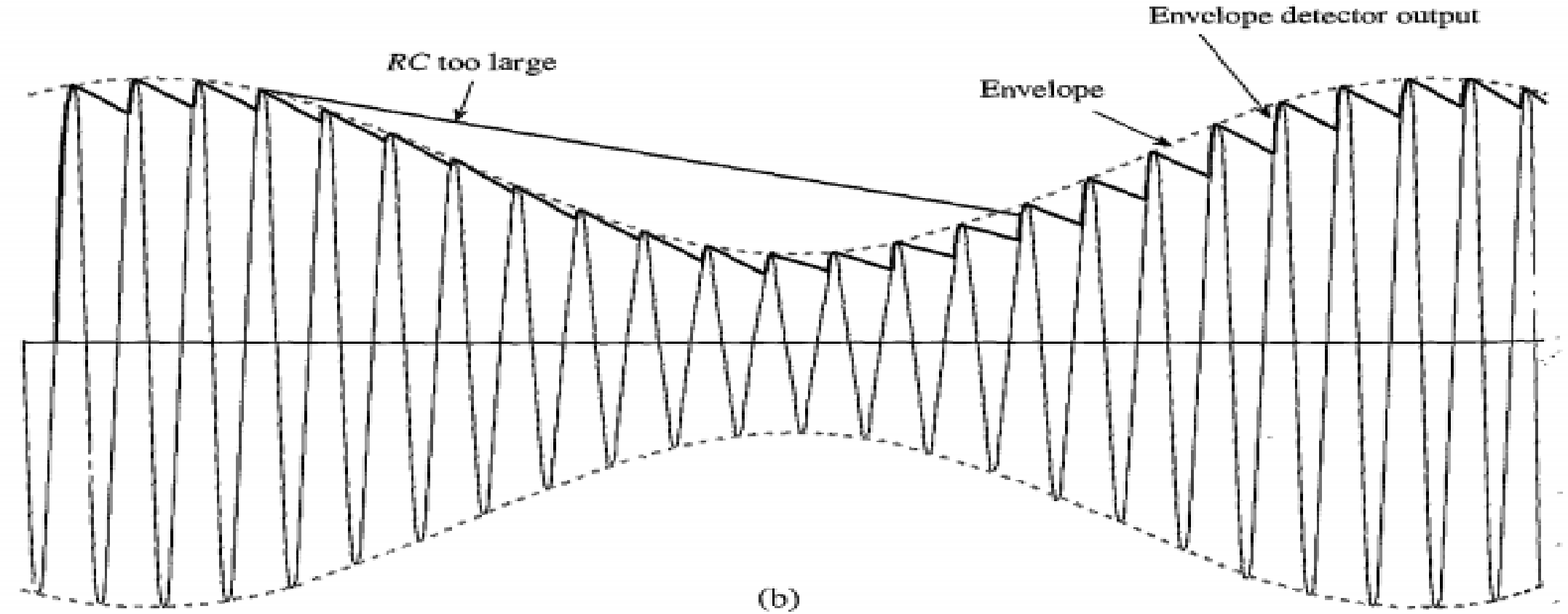
- The AM signal can be demodulated coherently by a locally generated carrier.

- However, coherent or synchronous demodulation goes against the main reason for using AM, and hence rarely used in practice.

- The envelope detector is a noncoherent method, and its output follows the envelope of the modulated signal.


AM signal
C
Capacitor discharge
R
+
$v_C(t)$
−

(a)


Envelope detector output
RC too large
Envelope

(b)

- On the +ve cycle of the input signal, the diode conducts, and the capacitor C charges up to the peak voltage of the input signal.

- As the input signal falls below this value, the diode is cutoff, because the capacitor voltage (which is very nearly the peak voltage) is greater than the input signal, and thus causes the diode to open.

- The capacitor now discharges through the resistor R at a slow rate (with a time constant RC).

- During the next positive cycle, the input signal becomes greater than the capacitor voltage, the diode conducts again, and the operation repeats.
- The output voltage across the resistor, thus, closely follows the envelope of the input.

- The discharge equation of the capacitor

$$v_c(t) = V_0 e^{-t/RC}$$

- The capacitor discharges between positive peaks, and thus a ripple signal appears at the output.

- The ripple can be reduced by increasing the time constant RC, so that the capacitor discharges very little between the positive peaks.

- Making RC too large, however, would make it impossible for the capacitor voltage to follow the envelope.

- The envelope detector output is $v_C(t) = A + m(t)$ with a ripple.

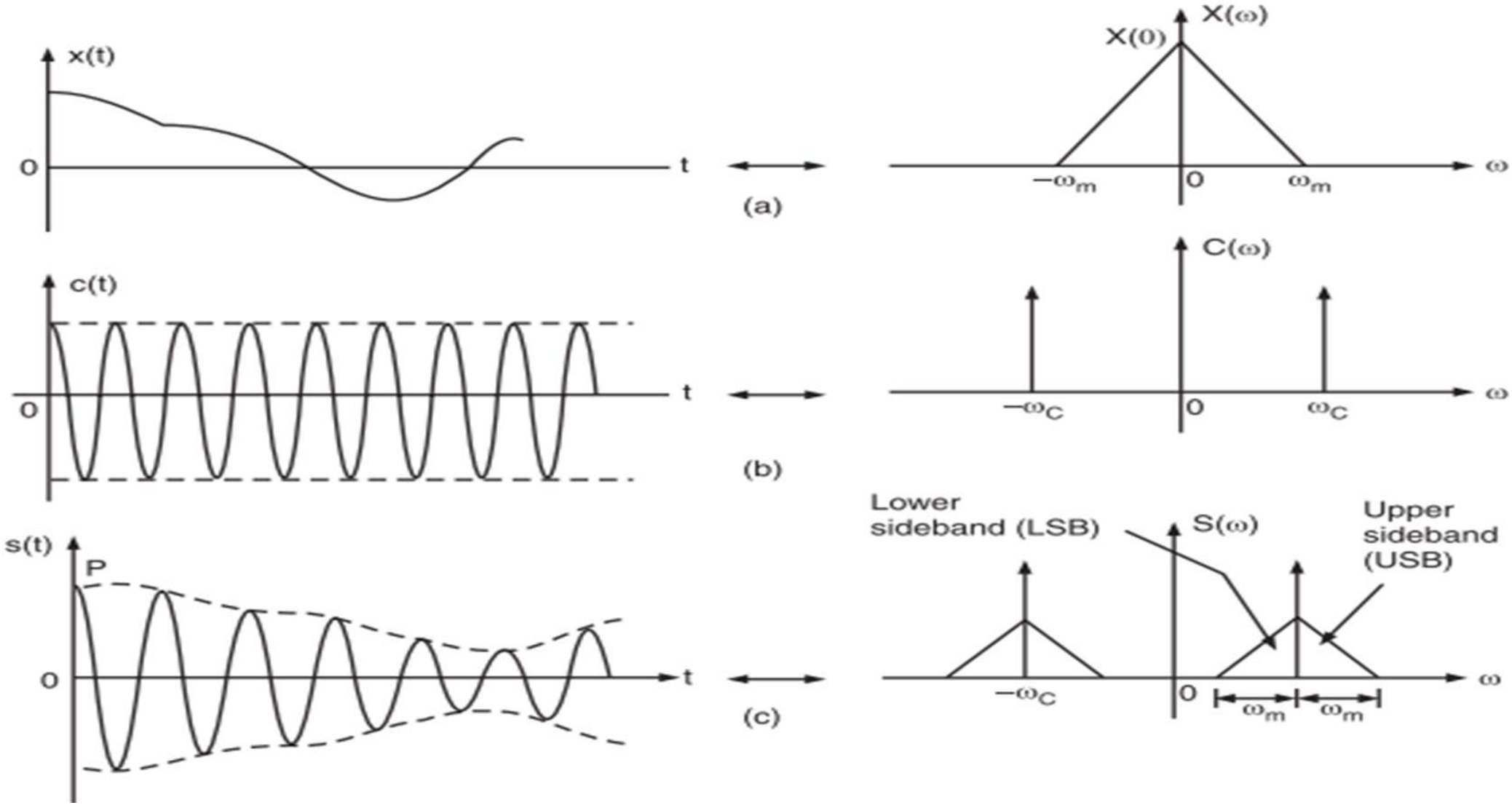
- The DC term A can be blocked out by a capacitor or a simple high-pass filter.

- The ripple may be reduced further by another low-pass filter.

- The carrier frequency is much greater than the highest frequency component of the message signal $f_c \gg f_m$

- We call f_m the message bandwidth.

- If this condition is not satisfied, an envelope cannot be visualized (and therefore cannot be detected) satisfactory.


x(t)
0
t
(a)
X(ω)
X(0)
−ωm
0
ωm
ω
c(t)
0
t
(b)
C(ω)
−ωC
0
ωC
ω
s(t)
P
0
t
(c)
Lower
sideband (LSB)
S(ω)
Upper
sideband
(USB)
−ωC
0
ωm
ωm
ω