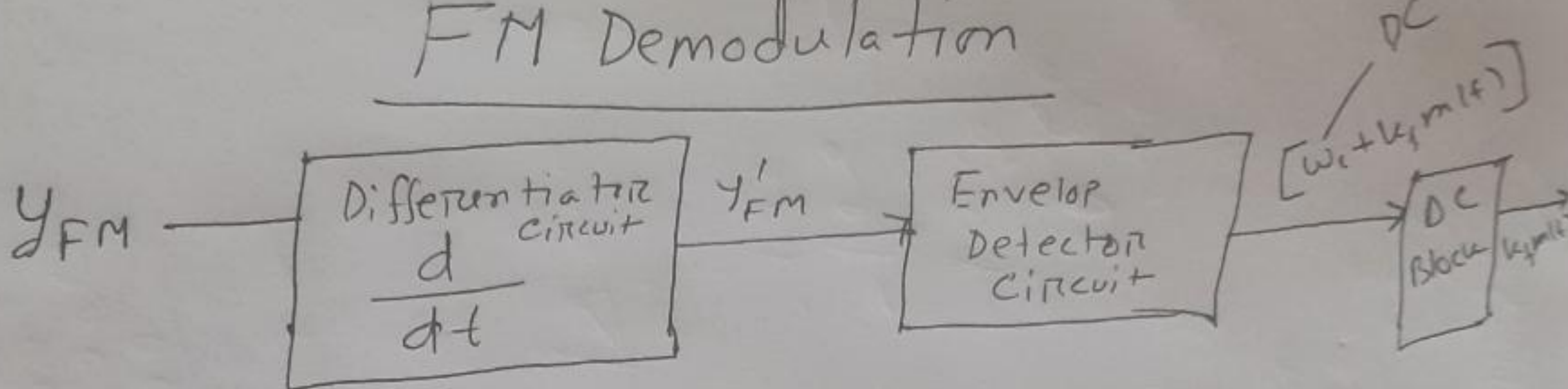
FM Demodulator

FM Demodulation



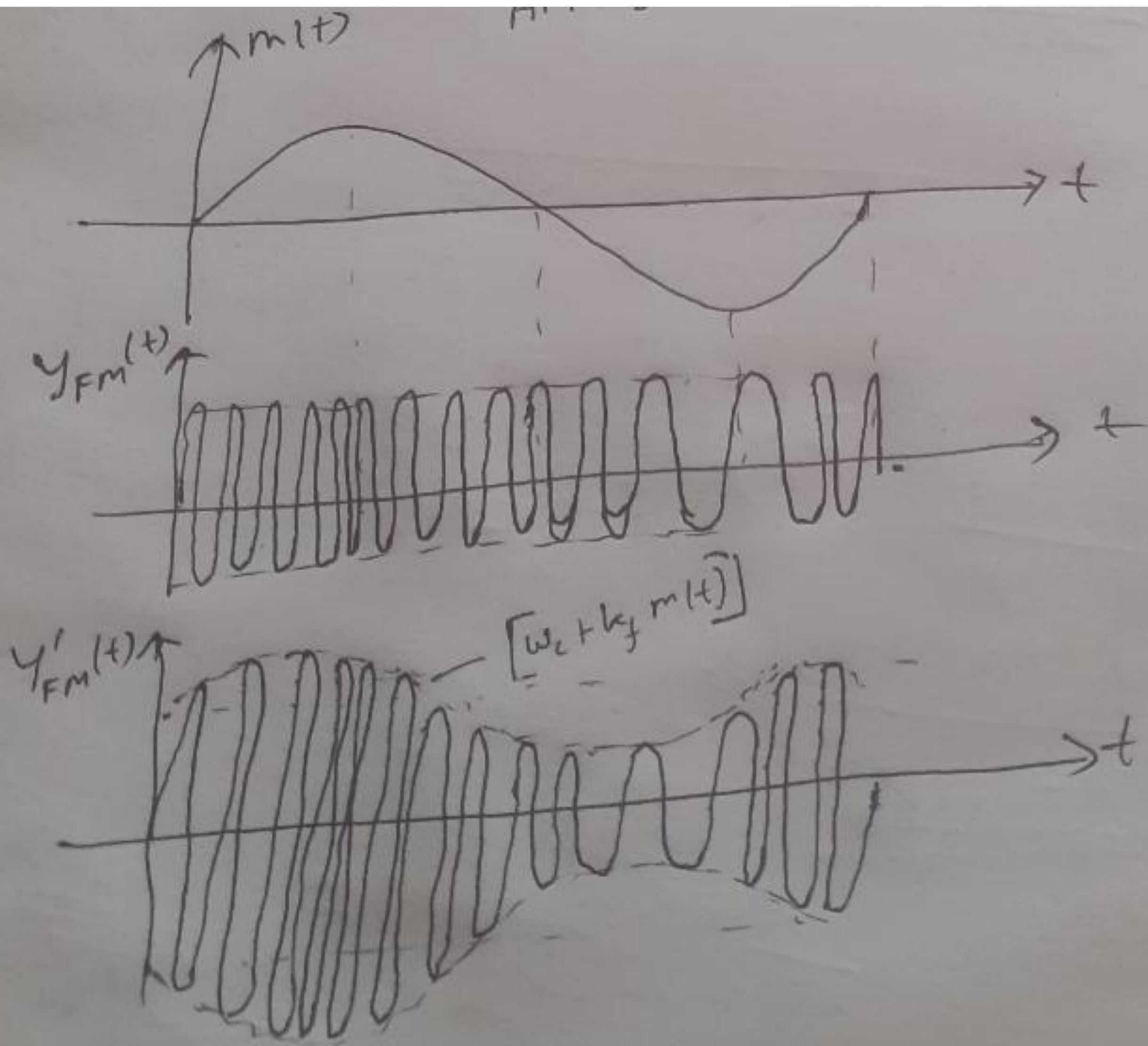
FM Signal

$$y_{FM}(t) = E_c \sin\left(\omega_c t + k_f \int m(t)\, dt\right)$$

After Differentiation

$$y'_{FM}(t) = \underbrace{E_c \left[\omega_c + k_f m(t)\right]} \cos\left(\omega_c t + k_f \int m(t)\, dt\right)$$

↑ AM signal Envelope



m(t)
t
$y_{FM}(t)$
t
$y'_{FM}(t)$
$[\omega_c + k_f m(t)]$
t

Envelope Detector

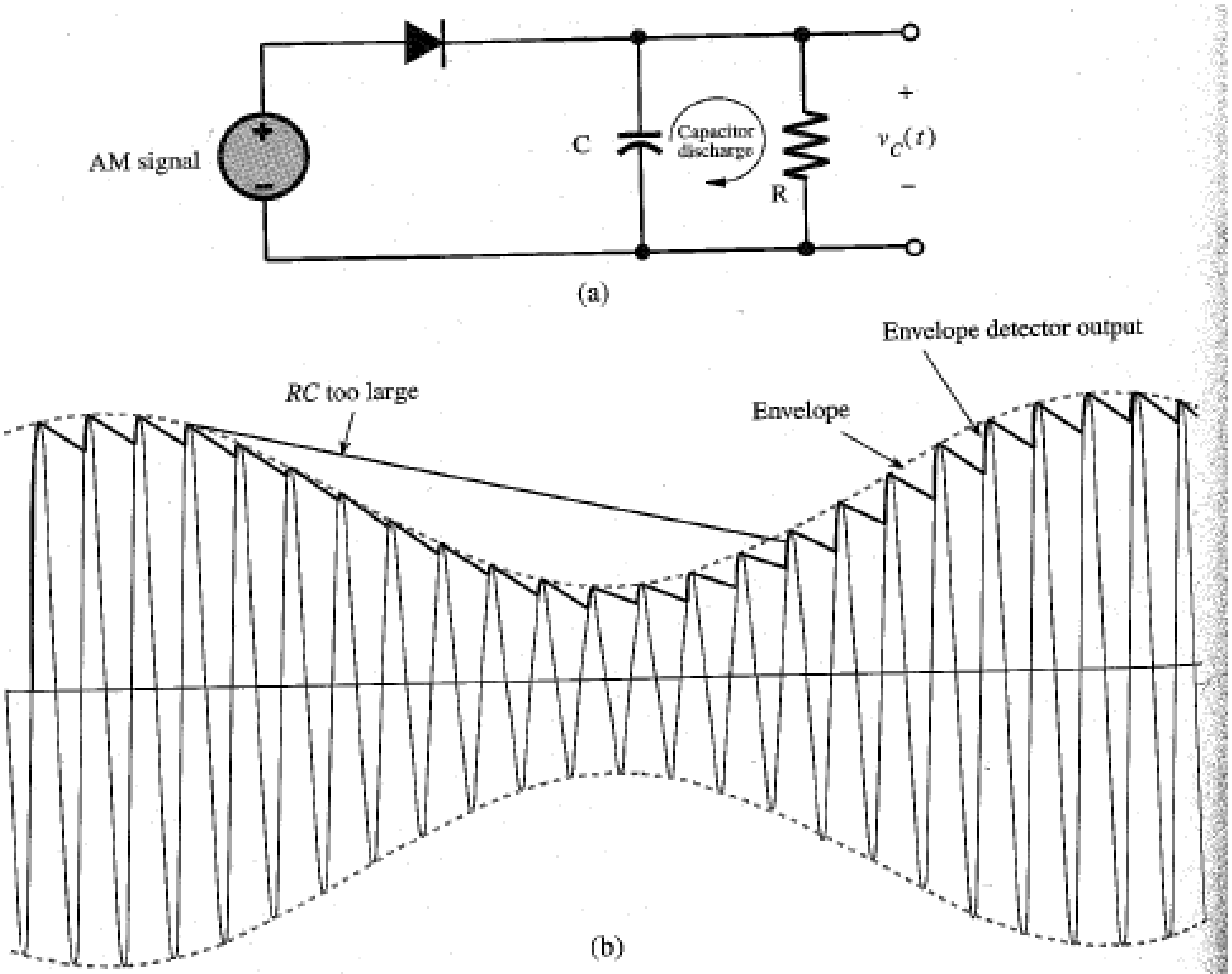
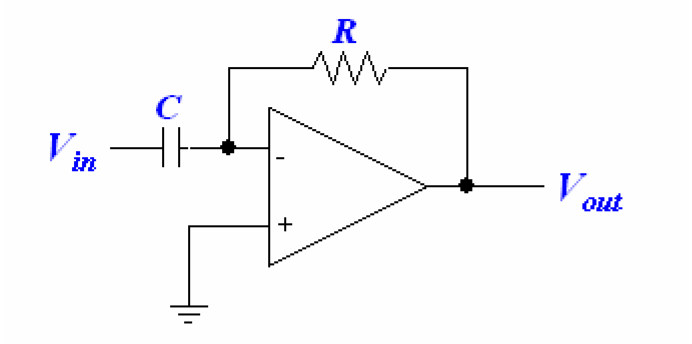


Figure 4.12 Envelope detector for AM.

Differentiator Circuit



- For DC Block we can use a capacitor
- Then We can use an amplifier to amplify the original message signal

Class Work:
Draw the complete Circuit Diagram of FM Receiver or Demodulator And Submit in Google Classroom and Facebook Group

Concept of Instantaneous Frequency and FM Modulated Signal and Transmitted Power

Concept of Instantanious Frequency and FM

Say a Carrier signal

$$x(t) = A\cos(\omega_c t + \theta_0)$$

$$= A\cos\theta$$

Now instantanious Frequency is

$$\omega_i = \frac{d\theta}{dt} = \frac{d}{dt}(\omega_c t + \theta_0) = \omega_c \text{ if } \theta_0 = 0$$

So $\theta(t) = \int_0^t \omega_i \, dt$

For, FM instantanious Frequency

$\omega_i(t) = \omega_c + k_f m(t)$ where

k_f is a constant

So $\theta(t) = \int_0^t (\omega_c + k_f m(t)) dt$

$= \omega_c t + k_f \int_0^t m(t) dt$

So FM Modulated signal.

(**) $\psi_{FM}(t) = A \cos\left[\omega_c t + k_f \int_0^t m(t) dt\right]$

So power needed to transmit FM signal is

$P_{avg} = \frac{A^2}{2}$

So for FM the instantanious frequency

$$\omega_i = \omega_c + k_f m(t)$$

Here carrier frequency deviation is $k_f m(t)$

Maximum carrier deviation is, Δf = Max value of $k_f m(t)$

EXAMPLE 5.5 An angle-modulated signal with carrier frequency $\omega_c = 2\pi \times 10^5$ is described by the equation

$$\varphi_{EM}(t) = 10 \cos(\omega_c t + 5 \sin 3000t + 10 \sin 2000\pi t)$$

- **(a)** Find the power of the modulated signal.
- **(b)** Find the frequency deviation Δf.
- **(c)** Find the deviation ratio β.
- **(d)** Find the phase deviation $\Delta\phi$.
- **(e)** Estimate the bandwidth of $\varphi_{EM}(t)$.

The signal bandwidth is the highest frequency in $m(t)$ (or its derivative). In this case $B = 2000\pi/2\pi = 1000$ Hz.

(a) The carrier amplitude is 10, and the power is

$$P = 10^2/2 = 50$$

(b) To find the frequency deviation Δf, we find the instantaneous frequency ω_i, given by

$$\omega_i = \frac{d}{dt}\theta(t) = \omega_c + 15,000 \cos 3000t + 20,000\pi \cos 2000\pi t$$

The carrier deviation is $15,000 \cos 3000t + 20,000\pi \cos 2000\pi t$. The two sinusoids will add in phase at some point, and the maximum value of this expression is $15,000 + 20,000\pi$. This is the maximum carrier deviation $\Delta\omega$. Hence,

$$\Delta f = \frac{\Delta\omega}{2\pi} = 12,387.32 \text{ Hz}$$

(c)

$$\beta = \frac{\Delta f}{B} = \frac{12,387.32}{1000} = 12.387$$

(d) The angle $\theta(t) = \omega t + (5 \sin 3000t + 10 \sin 2000\pi t)$. The phase deviation is the maximum value of the angle inside the parentheses, and is given by $\Delta\phi = 15$ rad.

(e)

$$B_{EM} = 2(\Delta f + B) = 26,774.65 \text{ Hz}$$