Outline

- FM Demodulation Techniques

FM Demodulator Classification

- Coherent & Non-coherent
  - A coherent detector has two inputs—one for a reference signal, such as the synchronized oscillator signal, and one for the modulated signal that is to be demodulated.
  - A noncoherent detector has only one input, namely, the modulated signal port.
  - **Example**: The envelope detector is an example of a noncoherent detector.
- Demodulator Classification
  - Frequency Discrimination
    - Noncoherent demodulator
    - FM→AM→ED→m(t)
  - Phase Shift Discrimination
    - Noncoherent demodulator
    - FM→PM→m(t)
  - Phase-Locked Loop (PLL) Detector
    - Coherent demodulator
    - Superior performance; complex and expensive

Let's look at each!

Frequency Discrimination

- Components
  - Bandpass Limiter: Consists of **Hard Limiter** & **BP Filter**
  - Discriminator (frequency discriminator gain: K_{FD} V/rad - assume unity)
  - Envelope Detector

$$v_2(t) = -V_L\left[\omega_c + \frac{d\theta(t)}{dt}\right]\sin[\omega_c t + \theta(t)]$$

$$v_{in}(t) = A(t)\cos[\omega_c t + \theta(t)]$$

$$v_1(t) = V_L\cos[\omega_c t + \theta(t)]$$

$$v_{out}(t) = \left|-V_L\left[\omega_c + \frac{d\theta(t)}{dt}\right]\right|$$

$$\theta(t) = K_f\int_{-\infty}^{t} m(t_1)\,dt_1$$

Note: Df=Kf
Freq. deviation sensitivity

THE OUTPUT WILL BE:

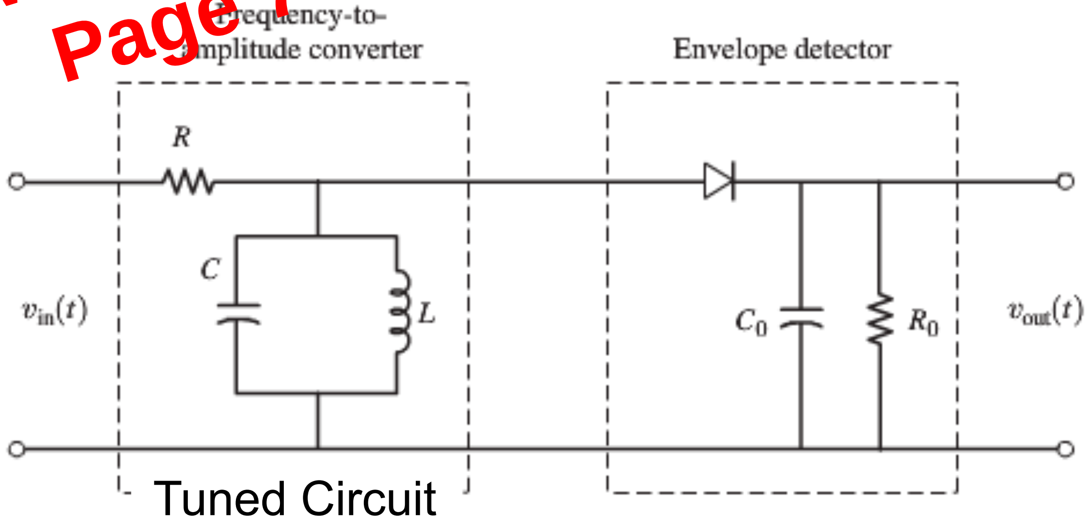
$$v_{out}(t) = V_L\left[\omega_c + \frac{d\theta(t)}{dt}\right]$$

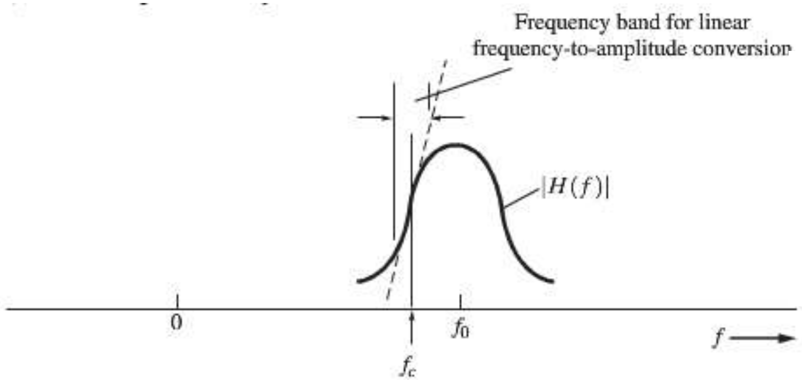
$$v_{out}(t) = V_L\omega_c + V_L K_f m(t)$$

DC Component can be blocked by an AC coupled circuit

Frequency Discrimination – Slope Detector

- In practice the differentiator can be approximated by a **slope detector** that has a linear frequency-to-amplitude transfer characteristic over the bandwidth BW –One drawback is that it is **narrow band**

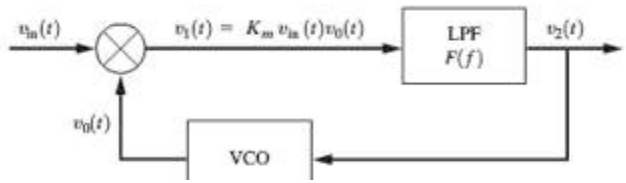




$$|H_{slope\_det}(f)| = \begin{cases} 2\pi K_{FD}\left|f - \left(f_c - \frac{B_T}{2}\right)\right| & f_c - \frac{B_T}{2} \leq f \leq f_c + \frac{B_T}{2} \\ 2\pi K_{FD}\left|f + \left(f_c - \frac{B_T}{2}\right)\right| & -f_c - \frac{B_T}{2} \leq f \leq -f_c + \frac{B_T}{2} \\ 0, & \text{otherwise} \end{cases}$$

BT is Carson's BW

Analog Loop Filter – First Order

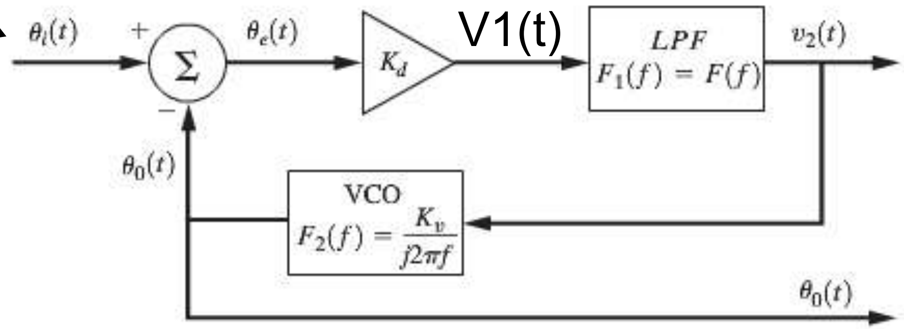


How does the control voltage v2(t) change if the frequency of the input signal changes?

$$\omega_{in}(t) = \omega_c + \Delta\omega \cdot u(t) \rightarrow \theta_i(t) = \Delta\omega \cdot t$$

$$\Theta_{in}(f) = \Delta\omega / (j\omega)^2 ; s = j\omega$$

$$\Theta_i(s) = \Delta\omega / (s)^2$$



$$v_1(t) = K_d \cdot v_o(t) \cdot v_{in}(t)$$

$$V_1(f) = K_d \cdot \Theta_e(f)$$