# AM/FM Receiver

# Communication Systems

- We have studied the basic blocks of any communication system
  - Modulator
  - Demodulator
- Modulation Schemes:
  - Linear Modulation (DSB, AM, SSB, VSB)
  - Angle Modulation (FM, PM)

# AM/FM Radio System

- Principles:
  - Frequency Spectrum Sharing (many transmitters using one medium)
  - Demodulating desired signal and rejecting other signals transmitted at the same time

# AM/FM Radio System

- The source signal is audio
- Different sources have different spectrum
  - Voice (speech)
  - Music
  - Hybrid signals (music, voice, singing)

# AM/FM Radio System

- Different audio sources have different bandwidth “W”
  - Speech- 4kHz
  - High quality music- 15kHz
  - AM radio limits “baseband” bandwidth W to 5kHz
  - FM radio uses “baseband” bandwidth W to 15kHz

# AM/FM Radio System

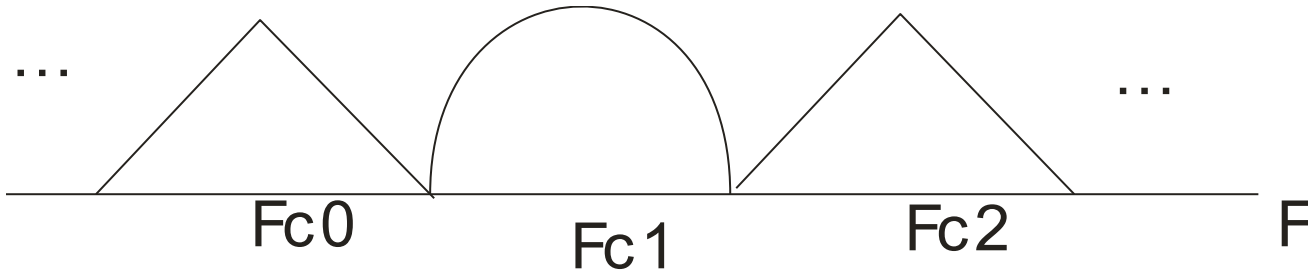
- Radio system should be able to receive any type of audio source simultaneously.
- Different stations with different sources transmit signals simultaneously.
- Different listeners tune to different stations simultaneously.

# AM/FM Radio System

- The different radio stations share the frequency spectrum over the air through AM and FM modulation.
- Each radio station, within a certain geographical region, is designated a carrier frequency around which it has to transmit
- Sharing the AM/FM radio spectrum is achieved through Frequency Division Multiplexing (FDM)

# Example of AM Radio Spectrum

- Different radio stations, different source signals




- Carrier spacing- 10kHz (AM)
- Bandwidth (3-5kHz)

# AM/FM Radio System

- For AM radio, each station occupies a maximum bandwidth of 10 kHz
- Carrier spacing is 10 kHz
- For FM radio, each station occupies a bandwidth of 200 kHz, and therefore the carrier spacing is 200 kHz

# AM/FM Radio System

- Transmission Bandwidth: $B_T$
- $B_T$ is the bandwidth occupied by a message signal in the radio frequency spectrum
- $B_T$ is also the carrier spacing
- AM: $B_T = 2W$
- FM: $B_T = 2(D+1)W$ (Carson's Rule)

# AM/FM Radio Receiver

- Design of AM/FM radio receiver
- The radio receiver has to be cost effective
- Requirements:
  - Has to work with both AM and FM signals
  - Tune to and amplify desired radio station
  - Filter out all other stations
  - Demodulator has to work with all radio stations regardless of carrier frequency

# AM/FM Radio Receiver

- For the demodulator to work with any radio signal, we "convert" the carrier frequency of any radio signal to

  Intermediate Frequency (IF)

- Radio receiver design can be optimized for that frequency
- IF filter and a demodulator for IF frequency

# AM/FM Radio Spectrum

- Recall that AM and FM have different radio frequency (RF) spectrum ranges:
  - AM: 540 kHz – 1600 kHz
  - FM: 88 MHz – 108 MHz
- Therefore, two IF frequencies
  - AM: 455 kHz
  - FM: 10.7 MHz

# AM/FM Radio Receiver

- A radio receiver consists of the following:
  - A Radio Frequency (RF) section
  - An RF-to-IF converter (mixer)
  - An Intermediate Frequency (IF) section
  - Demodulator
  - Audio amplifier