# Department of Communications Engineering

Communication Systems

Third Year Class

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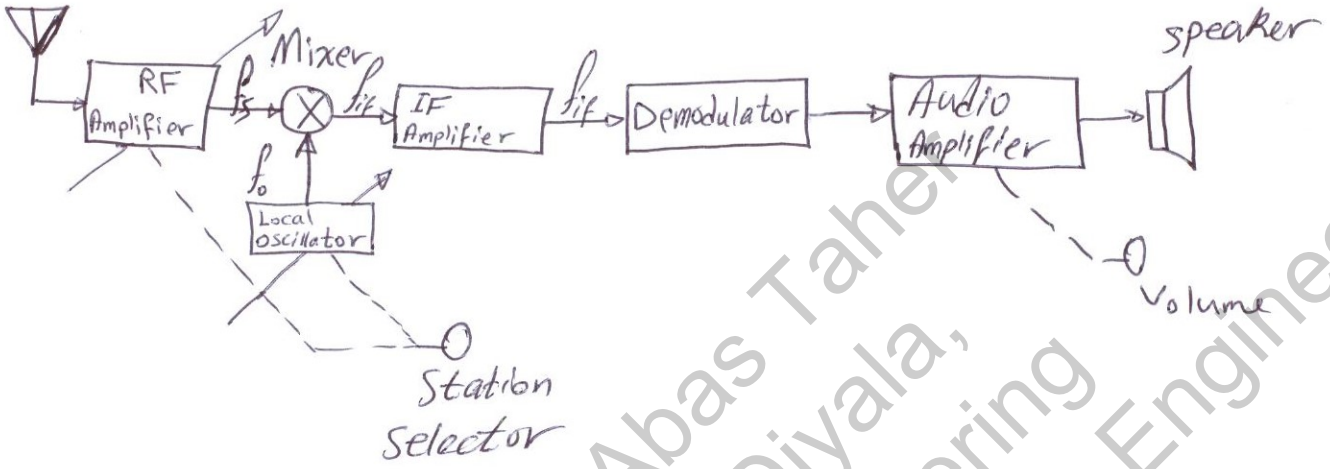
Lecture 12

## Super heterodyne Receivers I

# Superheterodyne Receiver :-




**RF-amplifier** :- It has a bandpass filter to select the band of operation and it has an amplifier. RF-amplifier is tunable amplifier (the BPF also tunable to the range of operation (the desired band of operation).

**Mixer** :- it is a non-linear circuit that multiply its two input to produce sum & difference, this is true when the inputs are both sinusoid.

**Local Oscillator** :- This is a tunable oscillator, the generated frequency $f_o = f_s \mp f_{if}$, the sum or difference depends on the application or the manufacturer.

IF-amplifier :- This is a fixed frequency section. It has an IF amplifier of the message's bandwidth and an amplifier.

Demodulator :- This part depends on the the type of application, it maybe an envelope detector or synchronous detector product detector etc..

Audio Amplifier :- Simply an amplifier to give gain to the signal. This amplifier has an external or man-made gain, in other words, the user can increase the gain or decrease it manually, which is the volume.

In superheterodyne Receiver, there are three main frequencies, $f_{station} = f_c = f_{RF}$, $f_{LO} = f_o$, and the IF-frequency (intermediate frequency) $f_{if} = f_I$.

(i) The desired station transmits at carrier frequency $f_c$ or $f_{station}$ or $f_s$ or usually it is called $f_{RF}$, the radio frequency.

FOR EXAMPLE: AM Broadcasting frequency

Range is: 550 KHz - to - 1600 KHz,

channel spacings: 10 KHz,

modulating signal: 100 Hz - to - 5 KHz,

FM Broadcasting frequency range from 88 MHz to 108 MHz.

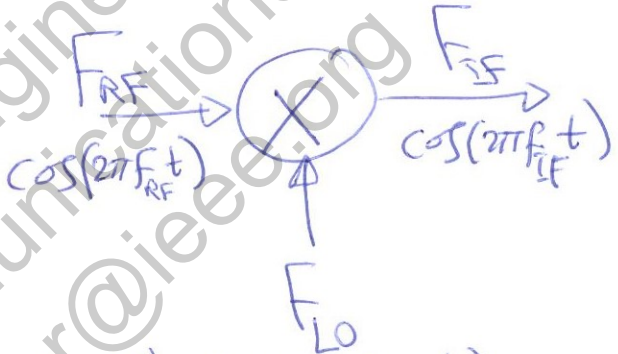
## (ii) Local oscillator frequency ($f_{LO}$).

the Local oscillator is a tuned oscillator. The free running frequency is fixed to a frequency called the intermediate frequency ($F_{IF}$). Thus, the local oscillator frequency $F_{LO}$ is

$$F_{LO} = F_{IF} \mp F_{RF} \quad \text{(1)}$$

OR $F_{LO} = F_R \mp F_{IF}$

in other words ...




$$\cos(2\pi F_{RF} t)\, 2\cos(2\pi F_{LO} t) = ?$$

we have $2\cos\theta\cos\varphi = \cos(\theta+\varphi) + \cos(\theta-\varphi)$

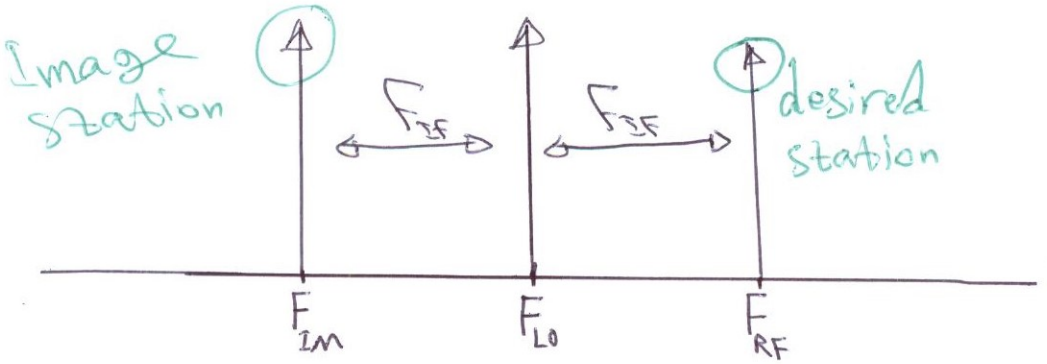
$$\therefore 2\cos(2\pi f_{RF} t)\cos(2\pi f_{LO} t) = \cos(2\pi f_{RF} t + 2\pi f_{LO} t) + \cos(2\pi f_{RF} t - 2\pi f_{LO} t)$$

Let:

$$\cos(2\pi F_{LO} t) = \cos(2\pi[F_{IF} \mp F_{RF}] t)$$

For High side injection: $F_{LO} = F_{RF} + F_{IF}$ $\Leftarrow$ $F_{LO} > F_{RF}$

For Low side injection: $F_{LO} = F_{RF} - F_{IF}$ $\Leftarrow$ $F_{LO} < F_{RF}$




(iii) Intermediate Frequency :- This is a fixed and usually standard frequency.

In order to avoide interference to receivers, the IF frequency has different standards according to the type of the application.

| IF-Frequency | Application |
|---|---|
| 262.5 KHz | AM-Broadcast radios (in automobiles). |
| 455 KHz | AM-Broadcast radios (Medium wave). |
| 10.7 MHz | FM-Broadcast radios. |
| 21.4 MHz | FM two-way radios. |
| 30 MHz | Radar receivers |
| 38.9 MHz | [Europe] TV. |
| 45 MHz | US TV. |
| 43.75 MHz | Video carrier for TV sets. |
| 60 MHz | Radar receivers |
| 70 MHz | Satellite Receivers |