Government of Rajasthan

GOVERNMENT POLYTECHNIC COLLEGE, PALI

Year: 2nd yr **Branch: Electronics** **Session: 2017-18**

EL-206: Wave Propagation & Communication Engineering

III MID TERM TEST

Duration: 1 Hr. **Max. Marks: 15**

Note: *Attempt any THREE questions. All question carry equal marks.*

Q.1 Define & explain critical frequency and maximum usable (MUF) frequency.

Critical frequency एवं maximum usable frequency को परिभाषित कीजिये एवं समझाइये

Ans.) Critical Frequency Formula

Radio frequency waves propagate between transmitter and receiver using antennas. The radio frequency at or below, the wave gets reflected from ionosphere and above this frequency waves penetrate through ionospheric layer. This is frequency is known as critical frequency.

$$f_{Cr} = \sqrt{81 N\text{max}}$$

Where ,

fcr = Critical frequency for the layer

N_{max} = Maximum ionization density (electrons per cubic meter)

The formula or equation of critical frequency is mentioned above. Critical frequency depends on atmosphere and angle of fire from transmitting antenna. Hence critical frequency value changes as per time of the day. In the equation, Nmax is maximum electron density or ionization density.

MUF | Maximum Usable Frequency Formula

Though critical frequency represents highest frequency which is reflected back from the layer at vertical incidence; it is not highest frequency which is reflected from the layer.

The highest frequency which can be reflected depends on angle of incidence and on distance between transmitter and receiver antennas.

$$\text{MUF} = \frac{\text{critical frequency}}{\cos\theta}$$

Where,

MUF = Maximum Usable Frequency

θ = Angle of Incidence

As mentioned in the MUF formula, it depends on critical frequency and angle of incidence. MUF (Maximum Usable Frequency) is the maximum frequency which can be reflected for given distance of transmission.

MUF is usually 3 to 4 times of critical frequency.

Q.2 Explain Yagi-Uda antenna with the help of the neat diagram.

Yagi-Uda एन्टोना को चित्र का सहायता से समझाइये !

Ans.) The Yagi antenna or Yagi-Uda antenna or aerial is a particularly popular form of antenna where directivity and gain are required.

Although the Yagi has become particularly popular for television reception, it is also used in many other applications, both domestic and commercial or professional. The gain and directivity of the Yagi antenna enable improved reception by enabling better levels of signal to noise ratio to be achieved, and by reducing interference levels by only picking up signals from a given direction.

The Yagi antenna design has a dipole as the main radiating or driven element to which power is applied directly from a feeder.

Further 'parasitic' elements are added which are not directly connected to the driven element but pick up power from the driven dipole element and re-radiate it. The phase is in such a manner that it affects the properties of the whole Yagi antenna as a whole, causing power to be focussed in one particular direction and removed from others.

There are three types of element within a Yagi antenna:

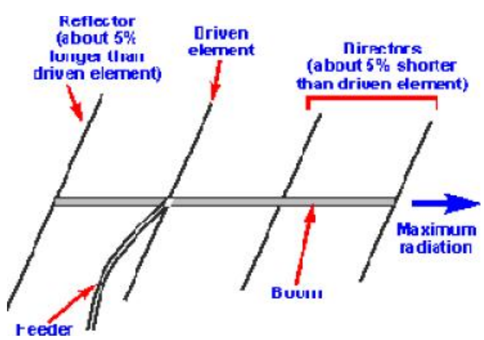

Fig. Yagi-Uda antenna

- ***Driven element:*** The driven element is the Yagi antenna element to which power is applied. It is normally a half wave dipole or often a folded dipole.
- ***Reflector:*** The reflector element is made to be about 5% longer than the driven element. The Yagi antenna will generally only have one reflector. This is behind the main driven element, i.e. the side away from the direction of maximum sensitivity. Typically a reflector will add around 4 or 5 dB of gain in the forward direction.
- ***Director:*** The director or directors are made to be shorter than the driven element. There may be none, one of more reflectors in the Yagi antenna. The director or directors are placed in front of the driven element, i.e. in the direction of maximum sensitivity. Typically each director will add around 1 dB of gain in the forward direction, although this level reduces as the number of directors increases.

The Yagi antenna exhibits a directional pattern consisting of a main forward lobe and a number of spurious lobes to the rear and the side.

Q.3 Draw the block diagram of AM superhetrodyne radio receiver and explain its operation.

AM superhetrodyne रेडियो रिसीवर का खंड आरेख बनाइये एवं इसकी कार्य प्रणाली समझाइये !

Ans.) The basic block diagram of a basic superhetrodyne radio receiver is shown below.

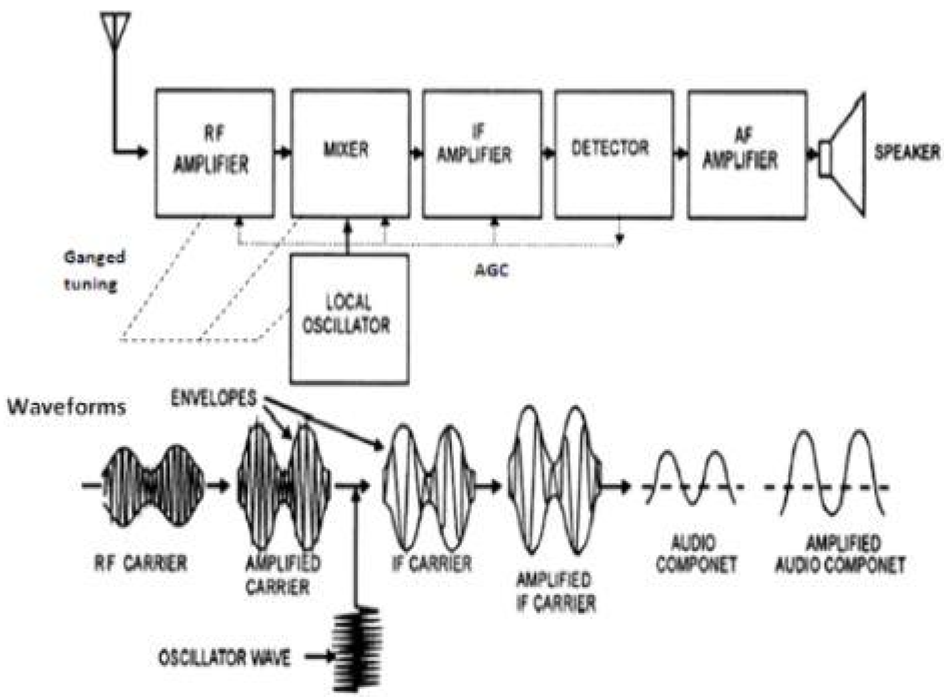

Fig.: AM superhetrodyne radio receiver

The function of the various block of the receiver is as follows:

- ***RF tuning & amplification:*** This RF stage within the overall block diagram for the receiver provides initial tuning to remove the image signal. It also provides some amplification. If noise performance for the receiver is important, then this stage will be designed for optimum noise performance. This RF amplifier circuit block will also increase the signal level so that the noise introduced by later stages is at a lower level in comparison to the wanted signal.

- ***Local oscillator:*** The local oscillator circuit block can take a variety of forms. Early receivers used free running local oscillators. Today most receivers use frequency synthesizers, normally based around phase locked loops. These provide much greater levels of stability and enable frequencies to be programmed in a variety of ways.

- ***Mixer:*** Both the local oscillator and incoming signal enter this block within the superheterodyne receiver. The wanted signal is converted to the intermediate frequency.

- ***IF amplifier & filter:*** This superheterodyne receiver block provides the majority of gain and selectivity. High performance filters like crystal filters may be used, although LC or ceramic filters may be used within domestic radios.

- ***Demodulator:*** The superheterodyne receiver block diagram only shows one demodulator, but in reality radios may have one or more demodulators dependent upon the type of signals being receiver.

- ***Audio amplifier:*** Once demodulated, the recovered audio is applied to an audio amplifier block to be amplified to the required level for loudspeakers or headphones. Alternatively the recovered modulation may be used for other applications whereupon it is processed in the required way by a specific circuit block.

Q.4 Explain the operation of the Foster Seelay FM demodulator

Foster Seelay FM demodulator का कार्य प्रणाली समझाइये !

Ans.) The Foster Seeley discriminator circuit is characterised by the transformer, choke and diodes used within the circuit that forms the basis of its operation.

he Foster Seeley detector or as it is sometimes described the Foster Seeley discriminator is quite similar to the ratio detector at a first look. It has an RF transformer and a pair of diodes, but there is no third winding - instead a choke is used.

Like the ratio detector, the Foster-Seeley circuit operates using a phase difference between signals. To obtain the different phased signals a connection is made to the primary side of the transformer using a capacitor, and this is taken to the centre tap of the transformer. This gives a signal that is 90° out of phase.

When an un-modulated carrier is applied at the centre frequency, both diodes conduct, to produce equal and opposite voltages across their respective load resistors. These voltages cancel each one another out at the output so that no voltage is present. As the carrier moves off to one side of the centre frequency the balance condition is destroyed, and one diode conducts more than the other. This results in the voltage across one of the resistors being larger than the other, and a resulting voltage at the output corresponding to the modulation on the incoming signal.

The choke is required in the circuit to ensure that no RF signals appear at the output. The capacitors C3 and C4 provide a similar filtering function.

Both the ratio detector and Foster-Seeley detectors are expensive to manufacture. Any wound components like the RF transformers are expensive to manufacture when compared with integrated circuits produced in vast numbers. As a result the Foster Seeley discriminator as well as the ratio detector circuits are rarely used in modern radio receivers as FM demodulators.

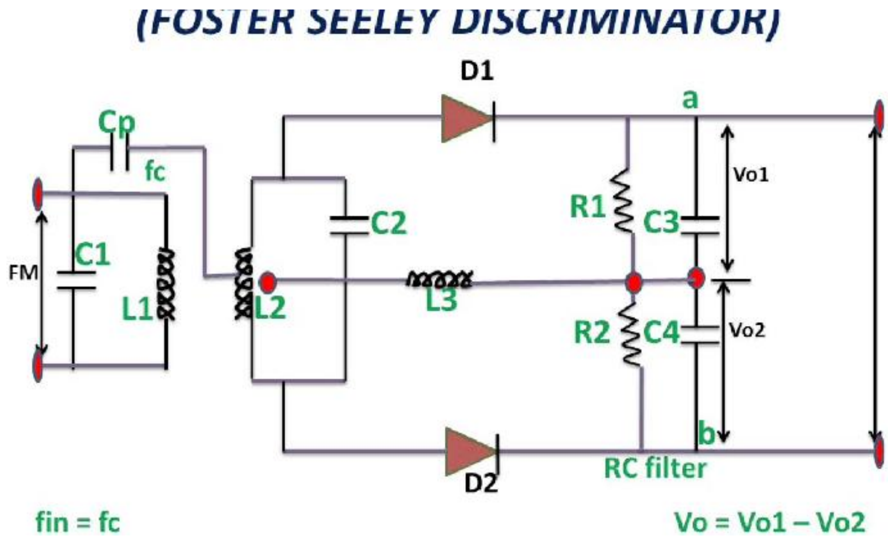

Fig.: Foster Seeley FM detector

Advantages of Foster-Seeley FM discriminator:

- Offers good level of performance and reasonable linearity.
- Simple to construct using discrete components.
- Provides higher output than the ratio detector
- Provides a more linear output, i.e. lower distortion than the ratio detector

Disadvantages of Foster-Seeley FM discriminator:

- Does not easily lend itself to being incorporated within an integrated circuit.
- High cost of transformer.
- Narrower bandwidth than the ratio detector

KHALID
Lecturer
GPC Pali