Q2 (a) What is modulation? Explain the need of it.

Answer

Q2 (a) Modulation is the process by which the communication signal that contains the information is combined with another signal at high frequency. The process of modulation means varying some characteristics of high frequency sinusoidal voltage according to the instantaneous value of another voltage.

Need for Modulation

(i) Modulation reduces the size of transmitting and receiving antennas for efficient radiation and reception. The transmitting and receiving antenna should have size comparable to the quarter wavelength of the signal frequency. The antenna height is 75 mt at 1 MHz and 5000 m at 15 kHz. A vertical antenna of the size is impractical.

(ii) It is extremely difficult to radiate low frequency signals through earth's atmosphere in the form of electromagnetic energy.

(iii) Information signals often occupy the same frequency band and if signals from two or more sources are transmitted at the same time, they will interfere with each other. To avoid interference with each other, each station translate its information to a different frequency band.

Q2 (b) Determine

(i) Noise figure for an equivalent noise temperature of 75 K.

(ii) Equivalent noise temperature for a noise figure of 6dB.

Use 290K for reference temperature.

Answer

(b) (i) $F = 1 + \frac{T_e}{T} = 1 + \frac{75}{290} = 1.258$

$NF = 10 \log (1.258) = 1 dB$

(ii) $F = \text{antilog} (NF/10) = \text{antilog} (6/10) = (10)^{0.6} = 4$

$T_e = T(F-1) = 290(4-1) = 870 K$

Q2 (c) What is the bandwidth of a modulated signal? Why is it a significant factor?

Answer

(C) Bandwidth is the frequency range between the lowest side band frequency and highest side band frequency. Since side bands carry intelegance, then the electronic circuit that process these modulated signals should be such that they respond equally to all side band frequency. Hence bandwidth becomes an important factor

Q3 (a) Compare various amplitude modulation system on the basis of practical merits.

Answer

Q:3 (i) In standard AM systems, the side bands are transmitted in full, accompanied by the carrier. Accordingly, demodulation is accomplished easily by using envelope detector or square law demodulater. On the other hand, in suppressed carrier systems the receiver is more complex, because additional circuitry must be provided for the purpose of carrier recovery. It is for this reason that we find commericial radio broadcast system, which involve one transmittee and numerious receiver

2. Suppressed carrier modulation systems have an advantage over AM system in that they require much less power to transmit the same amount of information which makes the transmitters far less expencive than those required for AM. Suppressed carrier systems are therefore suitable for point to point communication. The use of DSB-SC and SSB over standard AM is justified inspite of increased receiver complexity for point to point communication

3. The transmission Bandwidth for SSB is half as compared to standard AM or DSB-SC which justifies the use of USB as a prefered method of modulation over long distance transmission of voice signals over metallic circuit, because it permits longer spacing between repeaters.

4. Vestigial side band modulation require a transmission bandwidth that is intermediate between the required for SSB and DSB-SC systems and saving can be significant if modulating waves with large bandwidths are being handled, as in the case of television signals

Q3 (b) The a.c. r.m.s. antenna current of an AM transmitter is 6.2 A when unmodulated and rises to 6.7 A when modulated. Calculate the percentage of modulation.

Answer

$$\left(\frac{I_t}{I_c}\right)^2 = 1+\frac{m^2}{2} \qquad \frac{m^2}{2} = \left[\frac{I_t}{I_c}\right]^2 - 1$$

where I_t = modulated current = 6.7, I_c = unmodulated current 6.2

$$I_t = \left(\frac{6.7}{6.2}\right)^2 - 1 \qquad m = \sqrt{2(1.08)^2 - 1} = \sqrt{2(1.16-1)}$$

$$= \sqrt{0.32} = 0.56 = 56\%$$

Q3(c) Describe independent side band (ISB) system in brief.

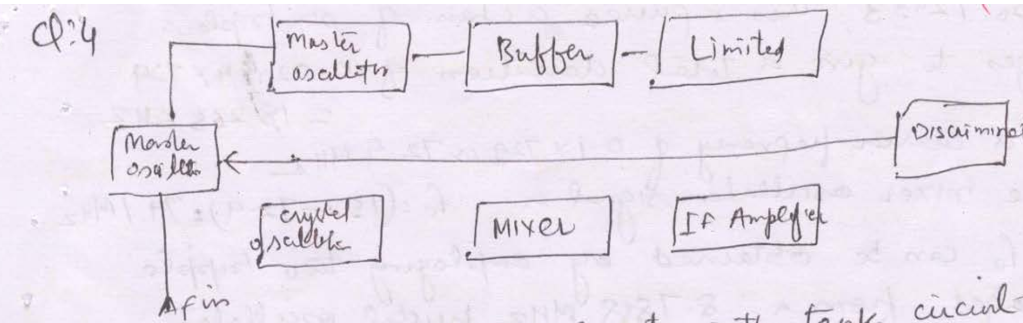
Answer

(c) For high density point to point communication multiplexing techniques are use. For low or medium density traffic ISB transmission is often employed. ISB essentially consists of two SSB channel added to form two side bands around the reduced carrier. However each side band is quite independent of each other. It can simultaneously convey a totally different transmission ~~to the extend~~ to the extent that upper side band could for example used for telephony while lower side band carrier telegraphy. It is not advisable ... telephony and telegraph channel in one side band

Q4 (a) Explain the operation of stabilized reactance modulator used for FM generation with the help of a neat block diagram.

Answer

Q.4



Reactance operates modulator operates on the tank circuit of an LC oscillator. It is isolated by buffer whose output goes through an amplitude Limiter to power amplifier. A sample of the output is taken from the limiter and fed to a mixer, which also receives the signal from a crystal oscillator. The resulting difference signal, which has a freq. usually about one twentieth of the master oscillator frequency, is amplified and fed to phase discriminator. The output of the discriminator is connected to the reactance modulator and provide a dc voltage to correct automatically any drift in the average frequency of the master oscillator.

Operation: The discriminator in the circuit must be connected to give a positive output if the input frequency is higher than the discriminator tuned frequency and negative output if it is lower. Consider the case, when frequency of master oscillator drifts high. A higher frequency will be fed to the mixer along with the output of a stable crystal oscillator. Mixer o/p will be fed to phase discriminator which tuned to a frequency which is proportional to the frequency difference between the two oscillators and its input frequency is now somewhat higher. The output of discriminator, positive dc voltage fed in series with the input of reactance modulator, increases its transconductance. The oscillator's central frequency given by the relation $f_0 = \frac{1}{2\pi\sqrt{LC}}$ may be lowered. Thus the frequency rise of master oscillator has been compensated.

Q4 (b) An Armstrong transmitter is to be used for transmission at 152 MHz in the VHF band with the maximum deviation of 15 kHz at a minimum audio frequency of 100 Hz. The primary oscillator is to be at 100 kHz and the initial phase modulation deviation is to be kept to less than 12^0, to avoid audio distortion. Find (i) the amount by which the frequency must be multiplied to give proper deviation and (ii) specify the combination of doublers and triplers, mixers crystal and any multiplier stages needed.

Answer

(b) The max. phase deviation of the modulator is

$$\Delta\phi_{max} = 12^0 = \frac{\pi}{180} \times 12 \text{ rad} = 0.2094 = m_p$$

$$f_{max} = \Delta\phi_{max} f_{min} = 0.2094 \times 100 = 20.94 \text{ Hz} = 0.02094 \text{ kHz}$$

So the required frequency deviation is

$$= \frac{\text{Max. freq. deviation allowed}}{\text{Max freq. deviation}} = \frac{f_{max} \text{ allowed}}{f_{max}}$$

$$= \frac{15 \times 10^3}{0.2094 \times 10^3} = 716.33.$$

Also $729 = 3^6$, this requires a chain of six tripler stages to give a total deviation of $0.02094 \times 729 = 15.265$ kHz at a carrier frequency of 0.1×729 or 72.9 MHz

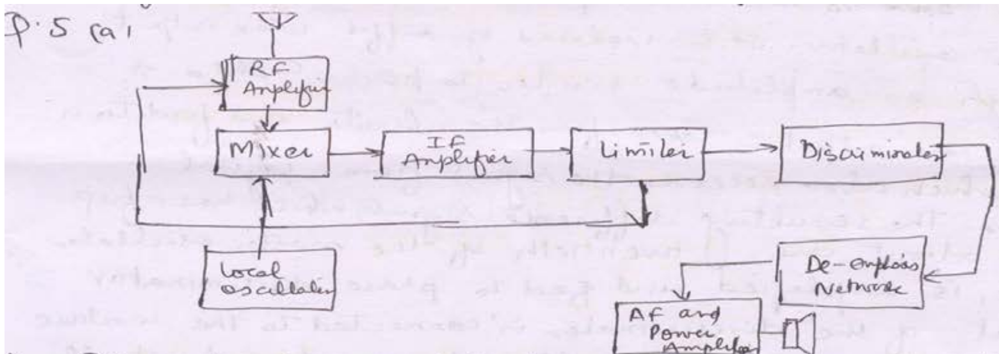
The mixer oscillator signal is $f_0 = (152 - 72.9) = 79.1$ MHz

So f_0 can be obtained by employing two tripple stages from a 8.7888 MHz crystal oscillator

Q5 (a) With the help of a neat block diagram, explain the functioning of a broadcast FM receiver.

Answer

P.5 (a)



The FM receiver is superheterodyne receiver the function of each block is detailed as under

RF Amplifier: It is used to reduce noise figure and to match the input impedance of the receiver to that of antenna. A typical FET grounded-gate RF amplifier is used due to the feature of low distortion

Frequency Changer: The oscillator ckt takes any of the usual form with the Colpitts and Clapp predominant being suited to VHF operation. Tracking is not normally much of a problem in FM broadcast receivers. This is because the tuning frequency range is only 1.25 : 1, much less than in AM broadcasting

Intermediate frequency Amplifier: IF and bandwidth required are far higher than in AM broadcast receivers. Typically figure for receivers operating in the 88 to 108 MHz band are an IF of 10.7 MHz and a bandwidth of 200 KHz. As a consequences of the large bandwidth gain per stage may be low. Hence two IF stages are provided

Discriminator: The discriminator extracts the intelligence from the high frequency carrier and also be called a detector as in AM receivers. By definition however,

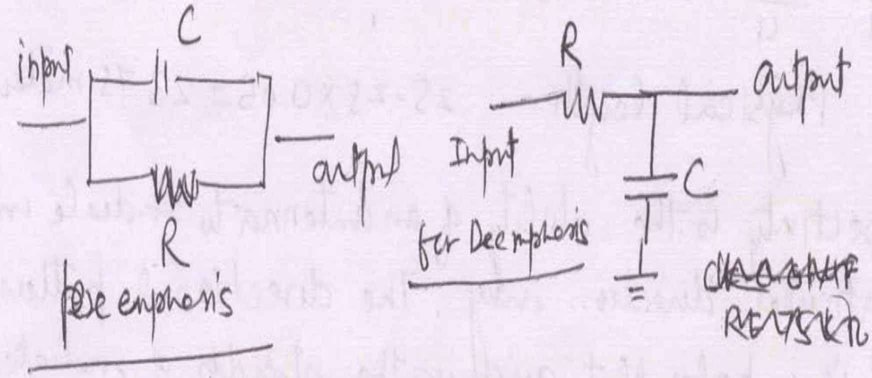
De-emphasis Network: The de-emphasis network following the discriminator is required to bring the high frequency intelligence back to the proper amplitude relationship with the lower frequencies. It may be recalled that the high frequencies were pre-emphasized at the transmitter to provide them with greater noise immunity and thus improved signal to noise ratio.

Use of limiter and AGC: In fact, the limiters in FM receivers are essentially used to provide an AGC function. Many FM receivers include a separate automatic frequency control function. This is a circuit that provides a slight automatic control over the local oscillator circuit. It compensates for the drift in local oscillator.

Q5 (b) The Pre-emphasis and De-emphasis used in other part of world are not necessarily 75 µs. Suppose that a 50 µs time constant is used, what is the necessary of -3db frequency? What resistance value can be used if the capacitor of the 75 µs pre-emphasis in the system is retained? Draw the RC circuit for Pre-emphasis and De-emphasis.

Answer

5(b)



-3db frequency $f = \frac{1}{2\pi RC}$

$RC = 50\,\mu s$ $\quad f = \frac{1}{2\pi \times 50}$ $\quad f = 3183\,Hz$

$R_1C_1 = 75 \quad R_2C_2 = 50$

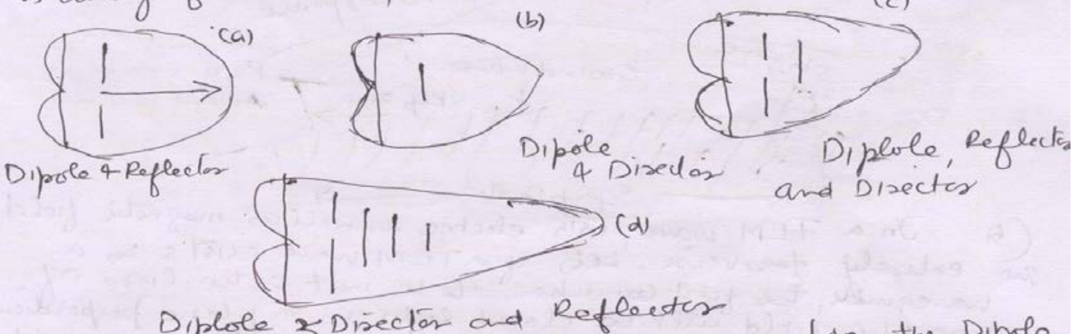
$C_2 = C_1 \quad \frac{R_1C_1}{R_2C_2} = \frac{75}{50} \quad \frac{R_1}{R_2} = \frac{3}{2}, \quad R_2 = \frac{2}{3}R_1$

$R_2 = 0.667R_1$

Q6 (a) How do directors and reflector affect the radiation pattern of an antenna structure?

Answer

6(a) A single dipole radiates both in the front as well as back so that front to back ratio almost unity. With the addition of reflectors the radiation is mostly in forward direction with a little radiation in backward direction thus improving front to back ratio. The space between dipole and reflector (= 0.2λ) is such that the radiation is away from the dipole.



Diplole & Director and Reflector

The Reflector reflects the e.m. energy away from the Dipole. Its length is larger than that of the dipole by approx 5%. In addition of another element whose length is shorter than the dipole and is spaced at a distance of about 0.12λ from the dipole also improve directivity, instead of reflecting the em waves, directs them into a narrower beam (c). A combination of director and reflector further gives improvement in the directivity of the antenna array. More the no. of element used, better the directivity.

Q6 (b) Design a Marconi antenna for a frequency of 3 MHz:

Answer

(b) $f = 3 \times 10^6$ Hz $\quad \lambda = \frac{3 \times 10^8}{3 \times 10^6} = 100$ metres

$\frac{\lambda}{4} = \frac{100}{4} = 25$ meters

Physical length = $25 - 25 \times 0.05 = 23.75$ meter

Q6 (c) What is directivity? What factors affect the directional pattern of antenna?

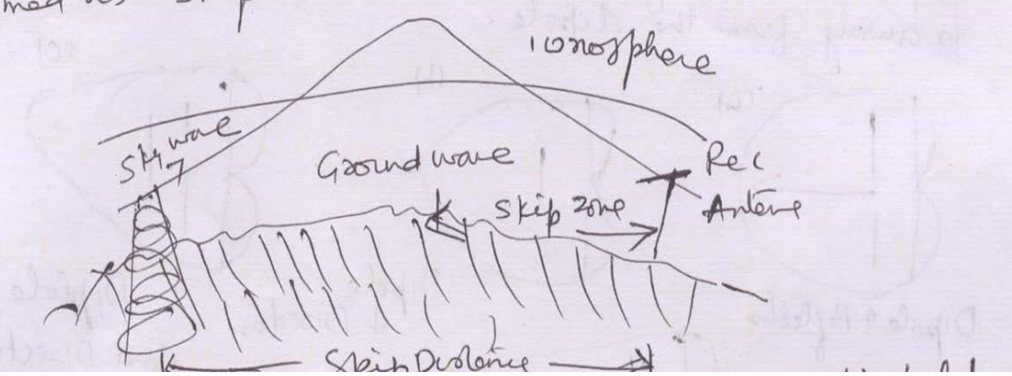
Answer

(c) Directivity is the ability of an antenna to radiate in a particular direction only. The directional pattern that is a polar plot gives us the strength of radiated e.m. waves and strength of received e.m. waves as a function of distance and angle.
The directional pattern is affected by the shape and size of antenna, point of feed of RF signal etc.

Q7 (a) Explain "skip-distance" and "skip-zone" with the help of suitable diagram.

Answer

Q. 7 The sky wave after reflection is received at a point much farther from the transmitting antenna. The only source for reception in the area is the ground wave. The distance between the transmitting antenna and the point where the skywave first reaches the earth is called 'Skip distance'. The ground wave becomes lesser and lesser significant as we move away from the transmitting antenna. A point comes after which there is no reception due to ground wave. If the point lies somewhere in the skip distance, then in the region between this point and point where skywave is received first, there is no reception at all. This region is termed as 'Skip Zone'



Q7 (b) Justify that a TEM wave cannot propagate in a single conductor hollow waveguide

Answer

(b) In a TEM wave, both electric as well as magnetic field are entirely transverse. If a TEM wave exists in a waveguide, the first condition to be met is the lines of magnetic field will be closed loops in a plane perpendicular to the propagation axis. According to Maxwell first equation magnetomotive force around each of these closed loop must equal to axial current. Now there cannot be any conduction current, the waveguide being hollow, and there can be axial current only if there is axial component of displacement current only if there is axial component of electric field which is again not there in TEM wave hence assumption that a TEM wave exist in hollow is wrong

Q7(c) A rectangular waveguide is 1cm x 2cm in dimensions. Calculate λ_c for TE_{10} and TM_{11} modes.

Answer

(c) $a = 2\text{ cm}$ $b = 1\text{ cm}$

cutoff wavelength (λ_c) for TE_{10} mode

$$\lambda_c = 2a = 2 \times 2 = 4 \text{ cm}$$

cutoff wavelength (λ_c) for TM_{11} mode

$$\lambda_c = \frac{2ab}{\sqrt{a^2+b^2}} = \frac{2\times2\times1}{\sqrt{(2)^2+(1)^2}} = \frac{4}{\sqrt{5}} = 1.79 \text{ cms}$$

Q8 (a) Explain the sampling theorem for band pass signal.

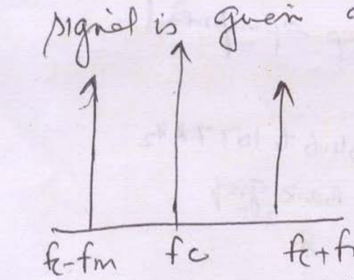
Answer

8(a) The sampling theorem applied to all band limited signals that contains no frequency components greater than f_m Hz. However, in case of Band Pass signal with a bandwidth that is small compared with the highest frequency component. it is possible to use a sampling rate that is less than twice the highest frequency component present in the signal.

Consider, a band pass signal, the spectrum of which occupies the frequency intervals

$$f_c - f_m \leq f_c \leq f_c + f_m$$ as shown in fig (1)

Band Pass Signal has a carrier frequency f_c and bandwidth $2f_m$. The minimum sampling rate required for such a signal is given as



Spectrum of Band Pass
fig (1)

$$\text{Sampling freq.} = \frac{2(f_c+f_m)}{m}$$

where $f_c + f_m$ = Highest freq. component

m = Largest possible integer

Q8 (b) A signal having bandwidth of 4.2 MHZ is transmitted using binary PCM system and the number of quantization levels is 512. Determine:

(i) code word length

(ii) transmission bandwidth

(iii) final bit rate

Answer

(b) $f_m = 4.2$ MHz, Quantization level $q = 512$

(a) $q = 2^v$, $512 = 2^v$, $\log_{10} 512 = v \log_{10} 2$

$v = \dfrac{\log_{10} 512}{\log_{10} 2}$ $v = 9$ bits i.e. Code word length

(b) $BW \geq v f_m = 9 \times 4.2 \times 10^6$ Hz ≥ 37.8 MHz

(c) Sampling rate $r = v f_s$

sampling frequency $f_s \geq 2 f_m$ $f_s \geq 2 \times 4.2$ MHz

Since $f_m = 4.2$ MHz

$f_s \geq 8.4$ MHz

Substituting this value of 'f_s' in equation,

$r = 9 \times 8.4 \times 10^6$ bits/sec $= 75.6 \times 10^6$ bits/sec

Q9 (a) Write short note on any <u>TWO</u> of the following:

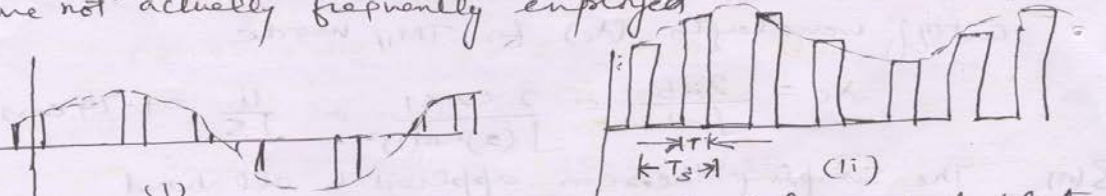
(i) flat top sampling

(ii) channel translating equipment

(iii) satellite communication

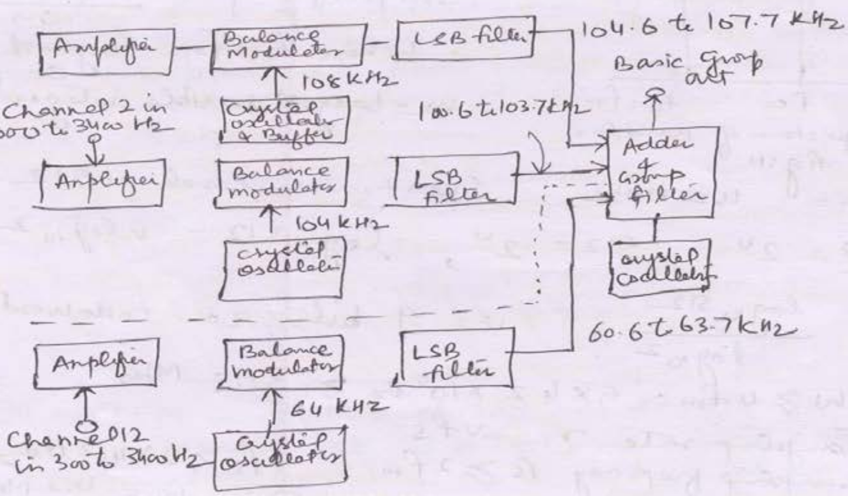
Answer

9 (a) Flat top sampling : Pulses of the type fig with top contoured to follow the waveform of the signal are not actually frequently employed



instead flat topped pulses are customarily used. A flat topped pulse has a constant amplitude established by the sample value of the signal at some point within the pulse interval. Thus the "flat-top sampling may be considered as first generating the instantaneous samples and then stretching the sample pulses to the duration T. The sampled pulses occur at the rate fs. It is Therefore evident that the sample pulses do not retain the signal shape during the occurrence of sampling pulses. flat top sampling has the merit that it simplifies the design of the electronic circuitry used to perform the sampling operation.

(b) Block Diag of Channel translating equipment



Text Book

Electronic Communication systems , George kennedy & Bernard Davis, 4 th edition (1999), Tata McGraw Hill publishing company Ltd.