K. RAMAKRISHNAN COLLEGE OF TECHNOLOGY
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EC8491 – COMMUNICATION THEORY
QUESTION BANK

UNIT-I AMPLITUDE MODULATION
(2 Marks Questions and Answers)

1. Define modulation?

Modulation is a process by which some characteristics of high frequency carrier Signal is varied in accordance with the instantaneous value of the modulating signal.

2. What are the types of analog modulation?

(i) Amplitude modulation.
(ii)Angle Modulation
1. Frequency modulation
2. Phase modulation.

3. Define the term modulation index for AM.

Modulation index is the ratio of amplitude of modulating signal (Em) to amplitude of carrier (Ec) i.e.m = mEC

4. What are the degrees of modulation?

a) Under modulation (m < 1)
b) Critical modulation (m=1)
c) Over modulation(m>1)

5. What is the need formodulation?

Needs for modulation:

a) Ease of transmission
b) Multiplexing
c) Reduced noise
d) Narrow bandwidth
e) Frequency assignment
f) Reduce the equipments limitations.

6. Give the Classification of Modulation.

There are two types of modulation. They are a)Analog modulation
b)Digital modulation

Analog modulation is classified as follows
(i)Continuous wave modulation
(ii)Pulse modulation

Continuous wave modulation is classified as follows
(i)Amplitude modulation
(ii)Double side band suppressed carrier
(iii)Single side band suppressed carrier
(iv)Vestigial side band suppressed carrier

Angle modulation
(i)Frequency modulation

(ii)Phase modulation

Pulse modulation is classified as follows

(i)Pulse amplitude modulation

(ii)Pulse position modulation

(iii)Pulse duration modulation

(iv)Pulse code modulation

Digital modulation is classified as follows (i) Amplitude shift keying (ii)Phase shift keying

(iii) Frequency shift keying.

7. What is the difference between high level modulation?

In high level modulation, the modulator amplifier operates at high power levels and delivers power directly to the antenna. In low level modulation, the modulator amplifier performs modulation at relatively low power levels. The modulated signal is then amplified to high power level by class B power amplifier. The amplifier feeds power to antenna.

8. Define Detection.

Detection is the process of extracting modulating signal from the modulated carrier. Different types of detectors are used for different types of modulations.

9. Define Amplitude Modulation.

In amplitude modulation, the amplitude of a carrier signal is varied according to variations in amplitude of modulating signal.

The AM signal can be represented mathematically as, $e_{AM} = (E_c + E_m \sin\omega_m t) \sin\omega_c t$ and the modulation index is given as, $m = \frac{E_m}{E_C}$

10. What is Super Heterodyne Receiver?

The super heterodyne receiver converts all incoming RF frequencies to a fixed lower frequency, called intermediate frequency (IF). This IF is then amplitude and detected to get the original signal.

11. What is single tone and multi tone modulation?

If modulation is performed for a message signal with more than one frequency component then the modulation is called multi tone modulation.

If modulation is performed for a message signal with one frequency component then the modulation is called single tone modulation.

12. Compare AM with DSB-SC and SSB-SC.

S.No	AM signal	DSB-SC	SSB-SC
1	Bandwidth = 2fm	Bandwidth = 2fm	Bandwidth = fm
2	Contains USB,LSB,Carrier	Contains USB,LSB	USB,LSB
3	More Power is required for transmission	Power required is less than that of AM.	Power required is less than

13. What are the advantages of VSB-AM?

1. It has bandwidth greater than SSB but less than DSB system.
2. Power transmission greater than DSB but less than SSB system.
3. No low frequency component lost. Hence it avoids phase distortion.

14. How will you generating DSBSC-AM?

There are two ways of generating DSBSC-AM such as a).Balanced modulator
b).Ring modulators

15. What are advantages of ring modulator?

a).Its output is stable.

b). It requires no external power source to activate the diodes.

c).Virtually no maintenance.

d). Long life.

16. Define Demodulation.

Demodulation or detection is the process by which modulating voltage is recovered from the modulated signal. It is the reverse process of modulation. The devices used for demodulation or detection are called demodulators or detectors. For amplitude modulation, detectors or demodulators are categorized as,

a) Square-law detectors b) Envelope detectors

17. Define Multiplexing.

Multiplexing is defined as the process of transmitting several message signals Simultaneously over a single channel.

18. Define Frequency Division Multiplexing.

Frequency division multiplexing is definedas many signals are transmitted simultaneously with each signal occupying a different frequency slot within a common bandwidth.

19. Define Guard Band.

Guard Bands are introduced in the spectrum of FDM in order to avoid any interference between the adjacent channels. Wider the guard bands, Smaller the interference.

20. Define SSB-SC.

(i) SSB-SC stands for Single Side Band Suppressed Carrier

(ii) When only one sideband is transmitted, the modulation is referred to as Single side band modulation. It is also called as SSB or SSB-SC.

21. Define DSB-SC.

After modulation, the process of transmitting the sidebands (USB, LSB) alone and suppressing the carrier is called as Double Side Band-Suppressed Carrier.

22. What are the disadvantages of DSB-FC?

(i) Power wastage takes place in DSB-FC

(ii) DSB-FC is bandwidth inefficient system.

23. Define Coherent Detection.

During Demodulation carrier is exactly coherent or synchronized in both the frequency and phase, with the original carrier wave used to generate the DSB-SC wave. This method of detection is called as coherent detection or synchronous detection.

24. **What is Vestigial Side Band Modulation?**

Vestigial Sideband Modulation is defined as a modulation in which one of the sideband is partially suppressed and the vestige of the other sideband is transmitted to compensate for that suppression.

25. What are the advantages of signal sideband transmission?

a) Power consumption

b) Bandwidth conservation c) Noise reduction

26. What are the disadvantages of single side band transmission?

a) Complex receivers: Single side band systems require more complex and expensive receivers than conventional AM transmission.

b) Tuning difficulties: Single side band receivers require more complex and precise tuning than conventional AM receivers.

27. Compare linear and non-linear modulators?

S.No	Linear Modulators	Non Linear Modulators
1.	Heavy filtering is not required.	Heavy filtering is required.
2.	These modulators are used in high level modulation.	These modulators are used in low level modulation.
3.	The carrier voltage is very much greater than modulating signal voltage.	The modulating signal voltage is very much greater than the carrier signal voltage.

28. What is frequency translation?

Suppose that a signal is band limited to the frequency range extending from a frequency f1 to a frequency f2. The process of frequency translation is one in which the original signal is replaced with a new signal whose spectral range extends from f1' and f2' and which new signal bears, in recoverable form the same information as was borne by the original signal.

29. What are the two situations identified in frequency translations?

a) Up Conversion: In this case the translated carrier frequency is greater than the incoming carrier

b) Down Conversion: In this case the translated carrier frequency is smaller than the increasing carrier frequency.

Thus, a narrowband FM signal requires essentially the same transmission bandwidth as the AM signal.

30. What is BW for AM wave?

The difference between these two extreme frequencies is equal to the bandwidth of the AM wave.

Therefore, Bandwidth, $B = (\omega c + \omega m) - (\omega c - \omega m)$ $B = 2\omega m$

31. What is the BW of DSB-SC signal?

Bandwidth, $B = (\omega c + \omega m) - (\omega c - \omega m)$ $B = 2\omega$

It is obvious that the bandwidth of DSB-SC modulation is same as that of general AM waves.

32.What are the demodulation methods for DSB-SC signals?

The DSB-SC signal may be demodulated by following two methods: (i) Synchronous detection method.

(ii) Using envelope detector after carrier reinsertion.

33.Write the applications of Hilbert transform?

(i) For generation of SSB signals,

(ii) For designing of minimum phase type filters, (iii) For representation of band pass signals.

34. What are the methods for generating SSB-SC signal?

SSB-SC signals may be generated by two methods as under:

(i)Frequency discrimination method or filter method. (ii)Phase discrimination method or phase-shift method.

13 Mark Questions :

1. Explain the generation of AM signals using Square Law Modulator.
2. Explain the detection of AM signals using Envelope Detector.
3. Explain about balanced modulator to generate DSB-SC signal.
4. Discuss about coherent detector to detect SSB-SC signal
5. Explain about the generation of SSB using Balanced Modulator.
6. Draw the circuit diagram of Ring Modulator and explain with its operation?
7. Discuss the coherent detection of DSB-SC modulated wave with a block diagram of detector and explain.
8. Draw the block diagram for the generation and demodulation of a VSB signal and explain the principle of operation.
9. Explain the method of generating AM waves using linear time invariant circuits.
10. Explain the method of generating AM waves using Non-Linear circuits.

UNIT-II ANGLE MODULATION

2Marks Questions and Answers

1. What do you understand by narrowband FM?

When the modulation index is less than 1, the angle modulated systems are called low index. The bandwidth requirement of low index systems is approximately twice of the modulating.

2. Define frequency modulation.

Frequency modulation is defined as the process by which the frequency of the carrier wave is varied in accordance with the instantaneous amplitude of the modulating or message signal.

3. Define modulation index of frequency modulation.

It is defined as the ratio of maximum frequency deviation to the modulating

$\beta = \delta f f m$

$\frac{}{}$

4. What do you meant by multitone modulation?

Modulation done for the message signal with more than one frequency component is called multitone modulation.

5. Define phase modulation.

Phase modulation is defined as the process of changing the phase of the carrier signal in accordance with the instantaneous amplitude of the message signal.

6. What are the types of Frequency Modulation?

Based on the modulation index FM can be divided into types. They are Narrow band FM and Wide band FM. If the modulation index is greater than one then it is wide band FM and if the modulation index is less than one then it is Narrow band FM

7. What is the basic difference between an AM signal and a narrowband FM signal?

In the case of sinusoidal modulation, the basic difference between an AM signal and a narrowband FM signal is that the algebraic sign of the lower side frequency in the narrow band FM is reversed.

8. What are the two methods of producing an FM wave?

Basically there are two methods of producing an FM wave. They are, i) Direct method: In this method the transmitter originates a wave whose frequency varies as function of the modulating source. It is used for the generation of NBFM

ii) Indirect method: In this method the transmitter originates a wave whose phase is a function of the modulation. Normally it is used for the generation of WBFM where WBFM is generated from NBFM

9. Compare WBFM and NBFM.

S.NO	WBFM	NBFM
1	Modulation index is greater than 1	Modulation index less than 1
2	Frequency deviation 75 KHz	Frequency deviation 5 KHz
3	Bandwidth 15 times NBFM	Bandwidth 2fm
4	Noise is more suppressed	Less Suppressing of noise

10. List the properties of the Bessel function.

The properties of the Bessel function is given by,

(i) $J_n(\beta) = (-1)^n J_{-n}(\beta)$ for all n, both positive and negative.

(ii) For small values of the modulation index β,

we have $J_0(\beta) = 1$

$J_1(\beta) = \beta/2$

$J_n(\beta) = 0$, n f 2

(iii) $\sum_{n=-\infty}^{\infty} J_n^2(\beta) = 1$

11. Give the average power of an FM signal.

The amplitude of the frequency modulated signal is constant .The power of the FM signal is same as that of the carrier power.

P =1 2 E 2c

12. Define phase deviation.

The maximum phase deviation of the total angle from the carrier angle is called phase deviation.

13. Define frequency Deviation.

The maximum departure of the instantaneous frequency from the carrier frequency is called frequency deviation.

14. Define the deviation ratio D for non-sinusoidal modulation.

The deviation ratio D is defined as the ratio of the frequency deviation f, which Corresponds to the maximum possible amplitude of the modulation signal m (t), to the highest modulation frequency.

D = Δf f m

15. What is the use of crystal controlled oscillator?

The crystal-controlled oscillator always produces a constant carrier frequency there by enhancing frequency stability.

16. What are the disadvantages of FM system?

1. A much wider channel is required by FM.

2.FM transmitting and receiving equipments tend to be more complex and hence it is expensive.

17. How will you generate message from frequency-modulated signals?

First the frequency-modulated signals are converted into corresponding amplitude-modulated signal using frequency dependent circuits. Then the original signal is recovered from this AM signal.

18. **What are the types of FM detector?**

The types of FM detectors are

(i) Slope detector and

(ii) Phase discriminator.

19. What are the types of phase discriminator?

The types of phase discriminator are (i) Foster seeley discriminator and (ii) Ratio detector.

20. What are the disadvantages of balanced slope detector?

1. Amplitude limiting cannot be provided
2. Linearity is not sufficient
3. It is difficult to align because of three different frequency to which various tuned circuits to be tuned.
4. The tuned circuit is not purely band limited.

21. Write the advantages and disadvantages of foster-seely discrimination method?

Advantages:

a) It is much easier to design

b) Only two tuned circuits are necessary and they are tuned to same frequency c) Linearity is better

Disadvantages:

a) It requires Amplitude limiting circuit.

22. What are the applications of phase locked loop?

Phase locked loops are used for various purposes in AM and FM communication. (i)Automatic frequency correction in FM transmitter uses PLL to keep carrier frequency constant.

(ii)PLL is used direct FM Tramitter uses PLL to keep carrier frequency constant. (iii) PLL is also used in FM demodulators.

23. Differentiate phase and frequency modulation.

S.No	Phase Modulation	Frequency Modulation
1	Phase of the carrier varies as per modulating amplitude	Frequency of the carrier varies as per amplitude variations of

24. A 80 MHz carrier is frequency modulated by a sinusoidal signal of 1V amplitude and the frequency sensitivity is 100 Hz/V. Find the approximate bandwidth of the FM waveform if the modulating signal has a frequency of 10 kHz.

Ans: Frequency Sensitivity = 100 Hz/
volt. Amplitude of modulating signal = 1V
Hence maximum frequency deviation, δ =100 Hz / volt ×1V= 100 kHz
Frequency of modulating signal, fm = 10kHz

$\therefore$ BW = 2 [δ + $f_{m\,(max)}$]

= 2 [100 +10×103] = 20.2 kHz

25. What is diversity reception?

Diversity reception is used when the signal fades into noise level. There are two types of diversity reception:

a) Space diversity

b) Frequency diversity.

a) Space diversity: It uses two or more receiving antennas separated by nine or more wavelengths. These are separate receivers for each antenna. The receiver with strongest signal is selected.

b) Frequency diversity: It uses single receiving antenna which works for two or more frequencies. The frequency which has strong signal is selected.

27. Obtain the bandwidth of the FM signal.

$c(t) = 10 \times \cos [2 \times 10^7 \times \pi t + 8 \cos (1000 \times \pi t)]$

Ans: Compare the given FM signal equation with standard FM signal equation, $c(t) = Ec \cos (\omega c\, t + m \cos \omega m\, t)$

Here, $m = 8$, $\omega m = 1000\,\pi$, Hence $f_m = 1000\,\pi$ or $f_m = 500$ Hz

$\delta = m f_m = 8 \times 500$ Hz $= 4000$ Hz

$BW = 2(\delta + f)$

$= 2 (4000 + 500) = 9000$ Hz or 9 kHz

28. State the disadvantages of FM.

i) Bandwidth requirement of FM is much higher.

ii) FM transmitting and receiving equipment is more complex and costly. iii) Distance of reception is limited only to line of sight.

29. What do you understand by FM stereo multiplexing?

FM stereo multiplexing is used for stereo transmission. It is basically frequency division multiplexing. It is used for FM radio broadcasting. The left and right channel signals are used to generate sum and difference signals. The difference signal frequency modulates the carrier. The difference signal, FM difference signal, FM difference signal and carrier are combined together and sent. Such FM multiplexed signal can be coherently received by stereo as well as mono receiver.

13 Mark Questions :

1. Explain the indirect method of generation of FM wave and any one method of demodulating an FM wave.
2. Discuss the indirect methods of generating a wide-band FM signal.
3. Draw the circuit diagram of Foster-seeley discriminator and explain its working.
4. Derive an expression for single tone FM wave and Narrowband FM wave?
5. Discuss the working of FM using Armstrong method.
6. Explain FM stereo multiplexing?

UNIT-III RANDOM PROCESS
2 Marks Questions and Answers

1. Define noise.

Noise is defined as any unwanted form of energy, which tends to interfere with proper reception and reproduction of wanted signal.

2. Give the classification of noise.

Noise is broadly classified into two types. They are (i)External noise
(ii)Internal noise.

3. **What are the types of External noise?**

External noise can be classified into

1. Atmospheric noise
2. Extraterrestrial noises
3. Man –made noises or industrial noises

4. What are types of internal noise?

Internal noise can be classified into

1. Thermal noise
2. Shot noise
3. Transit time noise
4. Miscellaneous internal noise

5. What are the types of extraterrestrial noise and write their origin?

The two type of extraterrestrial noise are solar noise and cosmic noise Solar noise is the electrical noise emanating from the sun.Cosmic noise is the noise received from the center part of our galaxy, other distant galaxies and other virtual point sources.

6. Define transit time of a transistor.

Transit time is defined as the time taken by the electron to travel from emitter to the collector.

7. Define flicker noise.

Flicker noise is the one appearing in transistors operating at low audio frequencies. Flicker noise is proportional to the emitter current and junction temperature and inversely proportional to the frequency.

8. State the reasons for higher noise in mixers.

1. Conversion transconductance of mixers is much lower than the transconductance of amplifiers.
2. If image frequency rejection is inadequate, the noise associated with the image frequency also gets accepted.

9. Define signal to noise ratio.

Signal to noise ratio is the ratio of signal power to the noise power at the same point in a system.

10. Define thermal noise. Give the expression for the thermal noise voltage across a resistor.

The electrons in a conductor possess varying amounts of energy. A small fluctuation in this energy produces small noise voltages in the conductor. These random fluctuations produced by thermal agitation of the electrons is called thermal noise.

11. Define noise temperature. (In terms of hypothetical temperature)

The available noise power is directly proportional to temperature and it is independent of value of resistance. This power specified in terms of temperature is called as noise temperature. It is denoted by Te . It is given as,

$Te = (F - 1)T$

12. What is shot noise?

When current flows in electronic device, the fluctuations number of electrons or holes generates the noise. It is called shot noise. Shot noise also depends upon operating conditions of the device.

13. Give the expression for noise voltage in a resistor.

The Mean –Square value of thermal noise voltage is given by, $Vn^2 = 4\ k\ TBR$

K – Boltz man constant, R – Resistance

T – Obsolute temperature, B Bandwidth

14. What is White Noise?

Many types of noise sources are Gaussian and have flat spectral density over a wide frequency range. Such spectrum has all frequency components in equal portion, and is therefore called white noise. The power spectral density of white noise is independent of the operating frequency.

15. What is narrowband noise?

The receiver of a communication system usually includes some provision for preprocessing the received signal. The preprocessing may take the form of a narrowband filter whose bandwidth is large enough to pass modulated component of the received signal essentially undistorted but not so large as to admit excessive noise through the receiver. The noise process appearing at the output of such filter is called narrow band noise.

18. Define noise equivalent bandwidth.

The noise equivalent bandwidth of the filter is defined as the bandwidth of an ideal filter at which the noise power passed by real filter and ideal filter is same.

19. Define noise factor.

Noise factor (F) is defined as the ratio of signal to noise power ratio at the input to signal to noise power ratio at the output

20. Give the characteristics of shot noise.

(i) Shot noise is generated due to fluctuations in the number of electrons or holes. (ii) Shot noise has uniform spectral density.

(iii) Mean square noise current depends upon direct component of current. (iv) Shot noise depends upon operating conditions of the device.

13 Mark Questions

1. Discuss the noise performance of different types of AM receivers in detail.
2. What is noise temperature? Deduce the expression for effective noise temperature for a cascaded system.
3. What is narrowband noise discuss the properties of the Quadrature components of a narrowband noise.
4. Derive the noise figure for cascade stages.
5. Explain about thermal noise.
6. Derive the Friis formula

UNIT-IV NOISE CHARACTERIZATION

2 marks questions and answers

1. What is FM threshold effect?

As the carrier to noise ratio is reduced, clicks are heard in the receiver output. As the carrier to noise ratio reduces further, crackling, or sputtering sound appears at the receiver output. Near the breaking point, the theoretically calculated output signal to noise ratio becomes large, but its actual value is very small. This phenomenon is called threshold effect.

2. What is capture effect in FM?

When the noise interference is stronger than FM signal, then FM receiver locks to interference. This suppresses FM signal. When the noise interference as well as FM signal are of equal strength, then the FM receiver locking fluctuates between them. This phenomenon is called capture effect.

3. What is meant by figure of merit of a receiver?

The ratio of output signals to noise ratio to channel signal to noise ratio is called figure of merit.,

4. What is the Purpose of re-emphasis and de-emphasis in FM?

The PSD of noise at the output of FM receiver sally increases rapidly at high frequencies but the PSD of message signal falls off at higher frequencies. This means the message signal doesn't utilize the frequency band in efficient manner. Such more efficient use of frequency band and improved noise performance can be obtained with the help of re-emphasis and de-emphasis.

5. What are extended threshold demodulators?

Threshold extension s also called threshold reduction. It is achieved with the help of FMFB demodulator. In the local oscillator is replaced by voltage controlled oscillator (VCO).The VC frequency changes as per low frequency variations of demodulated signal. Thus the receiver responds only to narrow band of noise entered around instantaneous carrier frequency. This reduces the threshold of FMFB receiver.

6. What is threshold effect with respect to noise?

When the carrier to noise ratio reduces below certain value, the message information is lost. The performance of the envelope detector deteriorates rapidly and it has no proportion with carrier to noise ratio. This is called threshold effect.

7. Define pre-emphasis and de-emphasis.

Pre-emphasis: It artificially emphasizes the high frequency components before modulation. This equalizes the low frequency and high frequency portions of the PSD and complete band is occupied.

De-emphasis: This circuit attenuates the high frequency components. The attenuation characteristic is exactly opposite to that of pre-emphasis circuit. De-emphasis restores the power distribution of the original signal.

The signal to noise ratio is improved because of pre-emphasis and de-emphasis circuits.

10. Define superheterodyne principle.

It can be defined as the process of operation of modulated waves to obtain similarly modulated waves of different frequency. This process uses a locally generated carrier wave, which determines the change of frequency.

11. Define signal to noise ratio.

Signal to noise ratio is the ratio of signal power to the noise power at the same point in a system.

12. What is threshold effect in an envelope detector? Explain.

When a noise is large compared to the signal at the input of the envelope detector, the detected output has a message signal completely mingled with noise. It means that if the input SNR is below a certain level, called threshold level, the noise dominates over the message signal, threshold is defined as value of the input signal to noise ratio (So/No) below which the output signal to noise ratio (Si/Ni) deteriorates much more rapidly than the input signal to noise ratio. The threshold effect in an envelope detector whenever the carrier power-to-noise power ratio approaches unity or less.

13 mark Questions:

1. i. Write a short note on (i) Shot noise with its power spectral density (7)
   ii. Thermal noise with PSD (6)
2. Describe in detail various sources of noise. (13)
3. What is coherent detector? Derive an expression for SNR at input (SNRc) and output of (SNRo) of a coherent detector. (13)
4. Express and derive the output SNR for FM reception. Also obtain the figure of merit. (13)
5. (i) Point out the significance of pre-emphasis and deemphasis in FM system. (7)
   (ii) Examine about FM threshold effect. (6)
6. Formulate the figure of merit for AM system using envelope detector. (13)
7. The three amplifiers 1, 2 and 3 have the following characteristics: F1=9dB, G1=48dB, F2=6dB, G2=35dB, F3=4dB, G3=20dB. The amplifiers are connected in cascade. Apply to find noise figure and equivalent noise temperature. (13)

UNIT V
SAMPLING & QUANTIZATION
2 Mark Questions with answers

1. List the advantages and disadvantage of digital communication system.
   1)Generally, more bandwidth is required than that for analog **systems**.
   2)High power consumption (Due to various stages of conversion).
   3)Complex circuit, more sofisticated device making is also

2. Define Band pass sampling.
   In signal processing, undersampling or **bandpass sampling** is a technique where one samples a **bandpass**-filtered signal at a **sample** rate below its Nyquist rate (twice the upper cutoff frequency), but is still able to reconstruct the signal.
3. Mention the definition of FDM.
   Frequency Division Multiplexing (**FDM**) is a networking technique in which multiple data signals are combined for simultaneous transmission via a shared communication medium. **FDM** uses a carrier signal at a discrete frequency for each data stream and then combines many modulated signals.
4. Distinguish natural and flat top sampling.
   Natural Sampling :

- Natural sampling is performed by multiplying w(t) by a train of pulses:

$Ws(t)=w(t)s(t)Ws(t)=w(t)s(t)$

Where $s(t)=\sum k=-\infty\infty P(t-kTs\tau)s(t)=\sum k=-\infty\infty P(t-kTs\tau)$

- Natural sampling takes a slice of the waveform and the top of the slice preserves the shape of the waveform.

Flat top sampling:

- In flat top sampling, the top of the samples remains constant and equal to the instantaneous value of the modulating signal at the start of the sampling.
- Thus the amplitude of the pulse after sampling is kept constant and the top of the sampled pulse do not follow the contour of the modulating signal unlike Natural sampling.
- The duration of each sample is τ and the sampling rate is $fs=1/Ts$
- Therefore, $Ts=1/fs$
- Sample and hold circuit is used for the generation of the sampled signal to attain flat top sampling.

5. Interpret the use of pre-filtering done before sampling.
   Pre-filtering is **done before sampling** to remove ambiguity between the continuous signals and discrete signals. Without such **filtering** there can be multiple continuous signals which can generate the same **samples**. ... Without such **filtering** there can be multiple continuous signals which can generate the same **samples**.
6. What is meant by aliasing?
   - Aliasing effect takes place when sampling frequency is less than Nyquist rate. Under such condition, the spectrum of the sampled signal overlaps with itself. Hence higher frequencies take the form of lower frequencies. This interference of the frequency components is called as aliasing effect.
   - A band limited signal of finite energy, which has no frequency components higher than W Hz, may be completely recovered from the knowledge of its samples taken at the rate of 2W samples per second.
7. How would you show your understanding of the components required for signal reconstruction?
8. The process of reconstruction, also commonly known as interpolation, produces a continuous time signal that would sample to a given discrete time signal at a specific sampling rate. Reconstruction can be mathematically understood by first generating a continuous time impulse train.

9. Write about non uniform quantization.
   Step size is not uniform. Non-uniform quantizer is characterized by a step size that increases as the separation from the origin of the transfer characteristics is increased. Non-uniform quantization is otherwise called as robust quantization. .
10. Illustrate the two fold effects of quantization process.
    1. The peak-to-peak range of input sample values subdivided into a finite set of decision levels or decision thresholds 2. The output is assigned a discrete value selected from a finite set of representation levels are reconstruction values that are aligned with the treads of the staircase.
11. What is the disadvantage of uniform quantization over the non-uniform quantization?
    SNR decreases with decrease in input power level at the uniform quantizer but non-uniform quantization maintains a constant SNR for wide range of input power levels. This type of quantization is called as robust quantization.
12. Construct the Nyquist sampling Theorem with equation.
    If a finite –energy signal g(t) contains no frequencies higher than W hertz ,it is completely determined by specifying its co=ordinates at a sequence of points spaced 1/2W seconds apart. ¾ If a finite energy signal g(t) contains no frequencies higher than W hertz, it may be completely recovered from its co=ordinates at a sequence of points spaced 1/2W seconds apart. ¾ A band limited signal of finite energy, which has no frequency components higher than W Hz, may be completely recovered from the knowledge of its samples taken at the rate of 2W samples per second.

13. Point out the μ-law of compression.
    The **μ-law** algorithm is a companding algorithm, primarily used in 8-bit PCM digital .... acoustic intensity level or loudness is logarithmic by **compressing** the signal using a logarithmic-response operational amplifier
14. How is PDM wave converted into PPM message?
    The PDM is signal is clock signal to monostable multivibraor. The multivibraor triggers on falling edge. Hence a PPM pulse of fixed width is produced after falling edge of PDM pulse. PDM represents the input signal amplitude in the form of width of the pulse. A PPM pulse is produced after the width of PDM pulse. In other words,the position of the PPM pulse depends upon input signal amplitude.Express the Quantization noise of a PCM system.
15. Outline the concept of TDM.
    Time-division multiplexing (**TDM**) is a method of transmitting and receiving independent signals over a common signal path by means of synchronized switches at each end of the transmission line so that each signal appears on the line only a fraction of time in an alternating pattern.
16. Summarize the advantages and disadvantages of FDM
    Advantages:
    There are some advantages of frequency division multiplexing(FDM) which are given below,

- It does not need synchronization between its transmitter and receiver.
- Frequency division multiplexing (FDM) is simpler and easy demodulation.
- Due to slow narrow band fading only one channel gets affected.
- It is used for analog signals.
- A large number of signals (channels) can be transmitted simultaneously.

Disadvantages:

There are some disadvantages of frequency division multiplexing (FDM) which are given below,

- It is suffers problem of cross-talk.
- It is used only when a few low speed channels are desired.
- Intermodulation distortion takes place.

17. What is PCM?

Pulse code modulation (PCM) is a method of signal coding in which the message signal is sampled, the amplitude of each sample is rounded off to the nearest one of a finite set of discrete levels and encoded so that both time and amplitude are represented in discrete form.. This allows the message to be transmitted by means of a digital waveform.

18. What is meant by quantization?
    While converting the signal value from analog to digital, quantization is performed. The analog value is assigned to nearest digital value. This is called quantization. The quantized value is then converted into equivalent binary value. The quantization levels are fixed depending upon the number of bits. Quantization is performed in every Analog to Digital Conversion.

19. The signal to quantization noise ratio in a PCM system depends on what criteria?
    The signal to quantization noise ratio in PCM is given as, (S/N) db $\leq$(4.8+6v)dB Here v is the number of bits used to represent samples in PCM. Hence signal to quantization noise ratio in PCM depends upon the number of bits or quantization levels.
20. What do you mean by companding?
    The signal is compressed at the transmitter and expanded at the receiver. This is called as companding. The combination of a compressor and expander is called a compander
21. Write an expression for bandwidth of binary PCM with N messages each with a maximum frequency of fm Hz.
    If „v‟ number of bits are used to code each input sample, then bandwidth of PCM is given as, BT $\geq$ N.v.fm .Here v. fm is the bandwidth required by one message.

13 Mark Questions :

1. (i) Explain the following terms with respect to sampling Aliasing, Signal Reconstruction and Aperture effect distortion (7)

   (ii) Outline Time Division Multiplexing system for N- number of channels. (6)

2. Illustrate the following sampling procedures with proper details for Natural Sampling and Flat top Sampling.(13)

3. (i) Find the sampling rate for the following signal m(t)=2[cos(500*pi*t).cos(1000*pi*t)] . (ii) Determine the the Nyquist Rate for m(t)=5*cos(5000*pi*t).$\cos^2$(8000*pi*t) .

4. Let the maximum spectral frequency component (fm) in an analog information signal be 3.3khz .Can you identify the frequency spectra of sampled signal under the following relationships between the sampled frequency (fs) and maximum analog signal frequency (fm) .

   (i) fs=2fm (7)

   (ii) fs>2fm & fs<2fm (6)

5. Compare the concept of Uniform and Non Uniform Quantization. (13)

6. A signal m(t) band limited to 4 KHz is sampled at the rate of 50% higher than Nyquist rate, the maximum acceptable error in the sample amplitude is 1% of peak amplitude. The quantized samples are binary coded. Find minimum bandwidth of a channel required to transmit the encode binary signal. (13)

7. Illustrate and describe the types of Quantizer. Describe the mid tread and midrise type characteristics of uniform quantizer with suitable diagram. (13)

8. (i) Elaborate in detail about logarithmic companding of speech signals (7)

(ii) Point out the sampling rate for the signal , given m(t)=(1/2*pi)[cos(4000*pi*t)cos(1000*pi*t)](6)

9. (i) Describe PCM system with neat block diagram? (7)

(ii) What is TDM and mention its applications. Explain the difference between analog TDM and digital TDM.