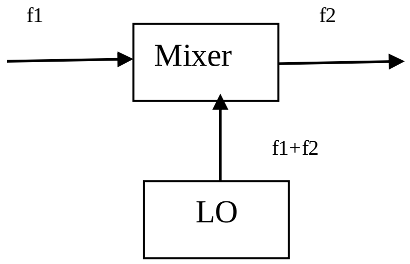
MOHAMED SATHAK A.J. COLLEGE OF ENGINEERING

(Approved by AICTE, New Delhi and Affiliated to Anna University, Chennai)

QUESTION BANK
EC8491 COMMUNICATION THEORY
II/ECE/IV SEMESTER

UNIT I –AMPLITUDE MODULATION Amplitude Modulation- DSBSC, DSBFC, SSB, VSB - Modulation index, Spectra, Power relations and Bandwidth – AM Generation – Square law and Switching modulator, DSBSC Generation – Balanced and Ring Modulator, SSB Generation – Filter, Phase Shift and Third Methods, VSB Generation – Filter Method, Hilbert Transform, Pre-envelope & complex envelope –comparison of different AM techniques, Superheterodyne Receiver	
UNIT-I / PART-A	
1	**What are the advantages of converting the low frequency signal into high frequency signal? Does the modulation technique decide the antenna height. (Nov/Dec 2016)(Apr/May 2017)** (1) The antenna needed for transmitting signals should have size at least λ/4, where, λ is the wavelength. The information signal, also known as baseband signal is of low frequency (and therefore the wavelength is high). If we need to transmit such a signal directly, the size of the antenna will be very large and impossible to build. Hence direct transmission is not practical. (2) The radiated power by an antenna is inversely proportional to the square of the wavelength. So, if we use high frequency signals, the power radiated will be increased (3) If we transmit the baseband signals directly, the signals from different transmitters will get mixed up and the information will be lost.
2	**An amplitude modulation transmitter radiates 100 watts of unmodulated power. If the carrier is modulated simultaneously by two tons of 40 percent and 60 percent respectively, calculate the total power radiated.** $m_t = \sqrt{m_1^2 + m_2^2} = \sqrt{0.6^2 + 0.4^2} = 0.73$ $P_t = P_c\left(1+\frac{m^2}{2}\right) = 127 \text{ watts}$ $P_c = \text{unmodulated carrier power},\ p_t = \text{total power}, m = \text{modulation index}$

<table>
<tr><td>3</td><td>Define modulation
Modulation is a process of varying the characteristics of high frequency carrier signal in accordance with the instantaneous value of the modulating signal.</td></tr>
<tr><td>4</td><td>What are the types of analog modulation?
The three types of analog modulation are amplitude modulation, frequency modulation and phase modulation.</td></tr>
<tr><td>5</td><td>Calculate the local oscillator frequency if incoming frequency is f_1 and translated carrier frequency is


The local oscillator frequency is
$fo = f_m + IF = f_1 + f_2$</td></tr>
<tr><td>6</td><td>Define depth of modulation or modulation index.
Depth of modulation is defined as the ratio of message signal amplitude to that of carrier signal amplitude. The modulation index of AM signal lies in the range from 0 to 1.</td></tr>
<tr><td>7</td><td>What are the degrees of modulation?
Degrees of modulation can be classified as (1) Under modulation - Modulation index<1, (2) Critical modulation, Modulation index =1 (3) Over modulation, Modulation index >1</td></tr>
<tr><td>8</td><td>What is the need for modulation?
Ease of transmission, multiplexing, reduced noise, narrow bandwidth, frequency assignment and reduce the equipment limitations.</td></tr>
<tr><td>9</td><td>What is single tone and multi tone modulation?
If modulation is performed for a message signal with one frequency component, then the modulation is called single tone modulation. If modulation is performed for a message signal with more than one frequency component then the modulation is called multi tone modulation.</td></tr>
<tr><td>10</td><td><table><tr><th>AM</th><th>DSB-SC</th><th>SSB-SC</th></tr></table>
Compare AM with DSB-SC and SSB-SC. (May 2018)</td></tr>
</table>

Transmission Bandwidth $B_T = 2f_m$	Transmission Bandwidth $B_T = 2f_m$	Transmission Bandwidth $B_T = f_m$
Contains two sidebands	Contains two sidebands	Contains only one sideband
Consumes large power	Consumes less power than AM.	Consumes less power than AM and DSB-SC.

11 **What are the advantages of VSB-AM?**

(i)The bandwidth of VSB-AM is greater than SSB but less than DSBSC system.

(ii)Power requirement of VSB-AM is greater than DSB but less than SSB system.

(iii)No low frequency component is lost. Hence, it avoids phase distortion.

12 **Compare linear and non-linear modulators.**

Linear modulators	Nonlinear modulators
Heavy filtering is not required	Heavy filtering is required
These modulators are used in high level modulation.	These modulators are used in low level modulation.

13 **Mention the properties of Hilbert transform?**

A signal $x(t)$ and its Hilbert transform $\hat{x}(t)$ have 1) the same amplitude spectrum 2) the same autocorrelation function 3) $x(t)$ and $\hat{x}(t)$ are orthogonal and 4) The Hilbert transform of $\hat{x}(t)$ is $-x(t)$.

14 **A broadcast radio transmitter radiates 5 kW power when the modulation percentage is 60 percent. How much is the carrier power?**

$$P_t = P_c\left(1+\frac{m^2}{2}\right)$$

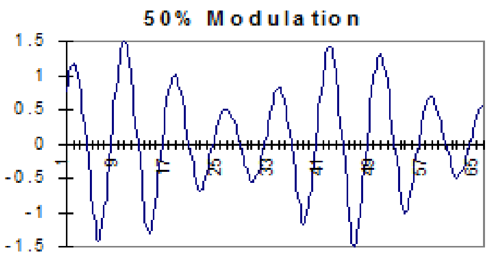
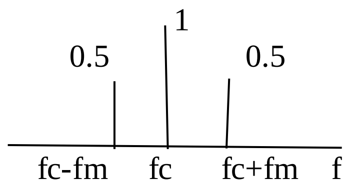
$$P_c = \frac{P_t}{\left(1+\frac{m^2}{2}\right)} = \frac{5000}{\left(1+\frac{0.6^2}{2}\right)} = 4237.28W$$

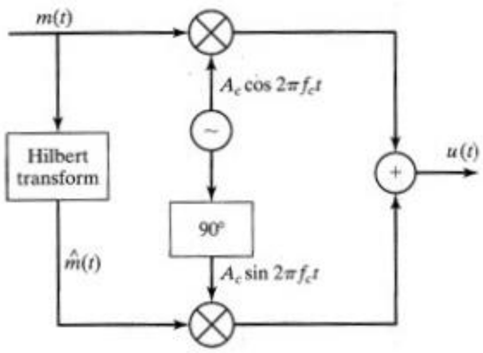
15 **What is the relationship between total power in AM wave and unmodulated carrier power?**

$$P_t = P_c\left(1+\frac{m^2}{2}\right)$$

$P_c = unmodulated\ carrier\ power,\ p_t = total\ power, m = modulation index$

16 **What is the relationship between total current in AM wave and unmodulated carrier current?**

	$I_t = I_c \sqrt{\left(1+\frac{m^2}{2}\right)}$ $I_t = total\ current, I_c = unmodulated\ carrier\ cuurent, m = modulation\ index$
17	**What is Hilbert transform?** Hilbert transform is a peculiar sort of filter that changes the phase of the spectral components depending on the sign of their frequency. It only effects the phase of the signal. It has no effect on the amplitude at all. The Hilbert transform $\hat{x}(t)$ o equation $$\hat{x}(t) = \frac{1}{\pi} \int_{-\infty}^{\infty} \frac{x(s)}{t-s}\, ds,$$
18	**What is pre-envelope? (May/June 2016).** The pre-envelope of a real signal $x(t)$ is the complex function $\mathbf{x_+(t) = x(t) + j\,\hat{x}(t)}$. The pre-envelope is useful in treating band pass signals and systems.
19	**Suggest a modulation scheme for the broadcast video transmission and justify. (Nov 2016)** VSB is preferred for TV transmission because of reduced bandwidth of modulation system and most of the required data present after modulation occupy the space near the carrier frequency.
20	**Define sensitivity of a radio receiver.** Sensitivity is the ability of the receiver to pick up weak signals and amplify them. It is defined in terms of the voltage that must be applied to the receiver input terminals to give the standard output power. It is usually expressed in micro volts.
21	**Define heterodyning. (May 2015, Nov/Dec 2018)** Heterodyning is the process of combining a radio frequency wave with a locally generated wave of different frequency. It is used very widely in communications engineering to generate new frequencies and move information from one frequency channel to another.
22	**Draw the AM wave for modulation index of 0.5 and its spectra. (May 2015).**  

23	**Draw the block diagram of SSB-AM generator. (Nov/Dec 2015)** 
24	**What is VSB? Where is it used? (Nov/Dec 2017)** Vestigial sideband (VSB) is a type of amplitude modulation (AM) technique (sometimes called *VSB-AM*) that encodes data by varying the amplitude of a single carrier frequency. Portions of one of the redundant sidebands are removed to form a vestigial sideband signal. The most prominent and standard application of VSB is for the transmission of television signals. Also, this is the most convenient and efficient technique when bandwidth usage is considered.
25	**Mention the drawbacks of coherent detection. (Apr/May 2018)** 1. Coherent detection is always lesser sensitive than incoherent detection. 2. Coherent detection detects only one polarization 3. Maximum coherently detected bandwidth is of few GHz 4. Coherent detection is electronically complicated, hence coherent array detectors are small (array receivers)
26	**Why DSBFC-AM bandwidth inefficient when compared with single side band AM? (April/May 2019)** The lower sideband and upper sideband contain similar message frequency components. In DSBFC, carrier along with upper sideband and lower sideband are transmitted. In SSB, only one sideband is transmitted. Hence, DSBFC requires more bandwidth to transmit carrier, lower sideband and upper sideband.
27	**Mention any four advantages of having RF amplifier in AM receiver. (April/May 2019)** The advantages of RF amplifier are (a) better selectivity (b) better sensitivity (c) Improved signal to noise ratio and (d) better gain
28	**Let a message signal has bandwidth of W. Write the modulated signal bandwidth if it is modulated by DSBSC and SSBSC. (Nov/Dec 2019)** Modulated signal bandwidth for DSBSC is 2W Modulated signal bandwidth for SSB is W
29	**Let a signal x(t) =A cos (w_ct) is passed through a Hilbert Transformer. Find the signal at the output y(t) of the Hilbert Transformer. (Nov/Dec**

	2019) Hilbert transform of a signal x(t) is defined as the transform in which phase angle of all components of the signal is shifted by ±90 degrees. When a signal x(t) =A cos(w_ct) is passed through a Hilbert Transformer, the output is A sin (w_ct)
30	**A carrier wave of frequency 10 MHz and peak value 10V is amplitude modulated by a 5 KHz sine wave of amplitude 6V. Determine the modulation index of the amplitude spectrum. (Nov 20, Apr 21)** Modulation index = message signal amplitude / carrier signal voltage = 6/10=0.6
31	**What are the merits of SSB modulation? (Nov 20, Apr 21)** 1. It allows multiple signals to transmit. 2. SSB technique requires less bandwidth as compared to DSB technique. 3. Less power is consumed. 4. It allows transmission of the high-power signal. **5.** It provides less interference to noise due to the reduction in bandwidth.
32	**What are the advantages of the conventional DSB-AM over DSB-SC and SSB-SC AM?** In DSB-AM, the carrier, Upper side band and Lower side band are transmitted. As a result there is no need for generation of carrier signal and synchronization of carrier at the receiver side. Hence the design of modulation and demodulation circuits in DSB-AM is simple.
UNIT-I / PART-B	
1	(i) Define amplitude modulation. How amplitude signals can be generated using a non-linear modulator circuit? (ii) Derive an expression for DSB-SC signal. Explain a method/balanced Modulator to generate and detect it. **(MAY2014)(Nov/Dec 2015) (May/June 2016) (Nov/Dec 2016) (April/may2017).**
2	(i) Compare amplitude modulation and frequency modulation. **(MAY 2014)** **(**ii)Explain the working of AM transmitter and that of a receiver with suitable block schematic **(MAY2014)**
3	(i) What is the need for modulation? Derive the expression for amplitude modulation and mention its merits and demerits. (ii) The output voltage of a transmitter is given by 500(1+0.4 sin 3140t) cos 6.28×10^7t. This voltage is fed to a load of 600 ohms. Determine 1) carrier frequency 2) modulating frequency 3) carrier power 4) total transmitted power. **(Nov 20, Apr 21)**
4	Describe the working of superheterodyne receiver with the help of block diagram. Discuss how image signal is formed and mention how it can be

	reduced. (**Nov/Dec 2017, Nov 20, Apr 21)**
5	Derive AM power distribution. Derive the AM wave equation and explain each term with the help of frequency spectrum. (or) Derive the modulated wave equation of an amplitude wave. Obtain power relation also. **(April/May2018)**
6	(i). Explain with suitable diagrams the generation of AM using square law method. Also derive its efficiency. (ii). Explain the demodulation of AM using envelope detection. **(Nov/Dec 2019)** (iii) Justify the range of values for modulation index with illustrations **(Nov/Dec 2019)**
7	(i) Discuss the detection process of DSB-SC and SSB-SC using coherent detector. Analyze the drawbacks of the suggested methodology. **(April/May2017)** (ii)Comment the choice of IF selection and image frequency elimination. **(April/May2017)**
8	**i)** Explain the operation of envelope detector. **(Nov/Dec2017)** ii) Discuss the generation of single sideband modulated signal.
9	i)Define the need of VSB modulation technique in TV broadcasting. Also sketch its frequency spectra**. (April/May2018)** ii**)**With the neat block diagram, elaborate the working principle of AM superheterodyne receiver. Also, highlight how superheterodyne receiver rectifies the drawback of TRF receiver with respect to receiver sensitivity. **(Nov/Dec 2018)**.
10	Draw an envelope detector used for demodulation of AM and explain its operation**.** A 10 KW carrier wave is amplitude modulated at 80 percent depth of modulation by a sinusoidal modulating signal. Calculate the side band power, total power and the transmission efficiency of the AM wave **(April/May 2019)**
11	(i)A message signal m(t)=cos 2000πt+2cos 4000πt modulates the carrier c(t)=100 cos2πf_ct where fc=1MHz to produce the DSB signal. (a) Determine the expression for USB signal (b)Determine and sketch the spectrum of USB signal. (c)Write a brief note on VSB. **(April/May 2019)**
12	Draw the spectrum and explain the generation of SSB signal using phase discriminator**. (Nov/Dec 2019)**
13	Let a superheterodyne receiver is used to demodulate a broadcast FM signal at 100.5 MHz using frequency discriminator and intermediate frequency of 10.7 MHz with high side injection of LO. (**Nov/Dec 2019**) (i)Draw the block diagram of the receiver and detail on how it improves sensitivity and selectivity over direct conversion (homodyne) receiver.

	(ii)Find LO frequency and image frequency. (iii)Comment on the image signal whether it is from or out of broadcast FM band and comment also on the selection of RF filter.
14	Derive the expression for canonical form representation of an SSB-SC wave and hence deduce the block diagram of Phase discrimination method for processing sidebands. **(Nov 20, Apr 21)**
15	i)Using the concept of Hilbert transform, generate the SSB SC wave using phase shift method. **(April/May2018)** ii)Using suitable circuit, explain the operation of envelope detector. Comment the reason for diagonal clipping and suggest the necessary conditions and expressions to overcome the same.

UNIT II ANGLE MODULATION C212.2

Phase and frequency modulation, Narrow Band and Wide band FM – Modulation index, Spectra, Power relations and Transmission Bandwidth - FM modulation – Direct and Indirect methods, FM Demodulation – FM to AM conversion, FM Discriminator - PLL as FM Demodulator.

UNIT-II / PART-A

1	**Define modulation index, with reference to FM and PM. (MAY 2013) (Nov2017)** Modulation index is the ratio of frequency deviation to the modulating signal frequency. $m = \frac{\Delta f}{f_m}$ where Δf = frequency deviation (Hz), f_m = modulating signal frequency (Hz)
2	**Why FM is preferable for voice transmission? (MAY 2014)** F.M transmission gives higher fidelity reception than A.M. transmission due to the presence of a large number of sidebands. FM reception is quite immune to noise as compared to AM reception
3	**How is the narrow band FM converted into wideband FM?** The narrowband FM is converted to wideband FM with the help of frequency multiplier. The frequency multiplier increases the frequency deviation as well as carrier frequency. It is called indirect method because FM is generated from PM.
4	**Define deviation ratio.** It is the worst-case modulation index which is the ratio of maximum permitted frequency deviation to the maximum modulating signal frequency. Deviation ratio = $m = \frac{\Delta f_{max}}{f_{m_{max}}}$
5	**State Carson's rule for determining approximate band width of FM**

	signal. (Nov/Dec 2017) According to Carson's rule, the bandwidth of FM signal is equal to twice the sum of frequency deviation and maximum modulating frequency. $Bandwidth = 2(\Delta f + f_{m\,max})$ Hz, where Δf be the frequency deviation (Hz), $f_{m(max)}$ be the highest modulating signal frequency (Hz).
6	**A carrier frequency is frequency modulated with a sinusoidal signal of 2 KHz resulting in a maximum frequency deviation of 5 KHz. Find the approximate band width of the modulated signal. (NOV 2013) (May 2015)** Δf = frequency deviation (Hz) = 5 KHz, $f_{m(max)}$ = highest modulating signal frequency (Hz) = 2 KHz, $Bandwidth = 2(\Delta f + f_{m\,max})$Hz = 2(5KHz + 2KHz) = 14 KHz
7	**Determine the modulation index of a FM system with a maximum frequency deviation of 75 KHz and maximum modulating frequency of 10 KHz.** $m = \frac{\Delta f_{max}}{f_{m\,max}} = \frac{75KHz}{10KHz}$ =7.5
8	**Distinguish between narrow band FM and wide band FM. (April/may 2019)**
9	**What are the advantages of FM over AM?** 1. Lesser distortion: Frequency modulated wave is less susceptible to interferences from buildings and traffic which provides improved signal to noise ratio (about 25dB) with respect to manmade interference. 2. Smaller geographical interference between neighboring stations. 3. Less radiated power. 4. Well defined service areas for given transmitter power.
10	**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.
11	**What are the two methods of producing an FM wave?** FM wave can be produced in two ways. 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 generates a wave whose phase is a function of the modulating signal. Normally it is used for the generation of WBFM where WBFM is generated from NBFM.
12	**Give the average power of a FM signal.**

Table for item 8:

Narrow band FM	Wide band FM
Frequency deviation is small	Frequency deviation is large
Bandwidth is twice the highest modulating frequency	Band width is calculated as per carson's rule

	The amplitude of the frequency modulated signal is constant. The average power of the FM signal is same as that of the carrier power. $P = \frac{1}{2}E_c^2$, where E_c is the carrier voltage.
13	**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.
14	**What are the disadvantages of balanced slope detector?** i)Amplitude limiting cannot be provided ii)Linearity is not sufficient iii)It is difficult to align because of three different frequencies to which various tuned circuits to be tuned. The tuned circuit is not purely band limited.
15	**What are the components in a frequency discriminator?** Frequency discriminator has got two components. Slope detector or differentiator with a purely imaginary frequency response that varies linearly with frequency. It produces output where the amplitude and frequency vary with the message signal. Envelope detector recovers the amplitude variations and reproduces message signal.
16	**What are the advantages of ratio detector?** i) Ratio detector is not affected by amplitude variations on the FM wave, ii) It can operate with as little as 100 mv of inputs.
17	**Define lock in range and dynamic range of PLL. (May 2015)** Lock in range is the range of input signal frequencies over which the loop remains locked once it has captured the input signal. This can be limited either by the phase detector or the VCO frequency range. Capture range is the range of input frequencies around the VCO center frequency onto which the loop will lock when starting from an unlocked condition.
18	**Compare amplitude and angle modulation schemes (Nov/Dec 2015)**

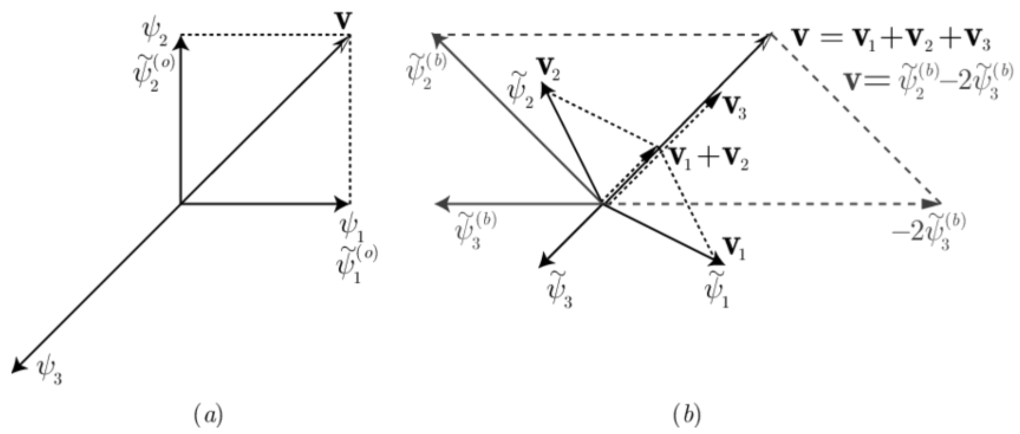
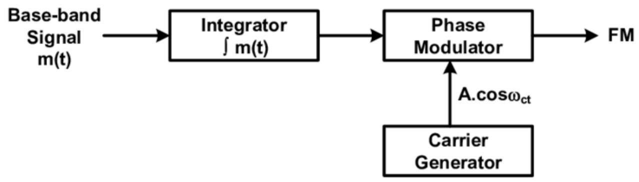
AM	FM
Each channel bandwidth is 15 KHz. In a given frequency space, AM accommodates a greater number of channels.	Each channel bandwidth is 150 KHz. In a given frequency space, FM accommodates a smaller number of channels.
AM reception is less immune to noise	FM reception is more immune to noise
AM receivers are not fitted with amplitude limiters	FM receivers can be fitted with amplitude limiters to remove amplitude variations caused by noise.
Amplitude of AM wave varies and is dependent on the	Amplitude of FM wave is constant and is independent of modulation

	modulation index.	index.

19	**A carrier signal is frequency modulated by a sinusoidal signal of 5 Vpp and 10 KHz. If the frequency deviation constant is 1 kHz/V, determine the maximum frequency deviation and state whether the scheme is narrow band FM or wide band FM. (May/June 2016)** Frequency deviation per volt = 1 KHz /v Maximum amplitude of the message signal = 5 Vpp Maximum frequency deviation = Frequency deviation per volt x Maximum amplitude of the message signal = 1 x 5 V =5 KHz. Modulation index = Maximum frequency deviation / modulating frequency = 5 KHz/ 10 KHz = 0.5. As the modulation index is less than one, it's a narrow band FM.
21	**Define carrier swing. (April/May2017)** The total variation in frequency from the lowest to the highest is referred as carrier swing. The carrier swing is equal to twice the frequency deviation.
22	**A frequency modulated signal is given as $S(t) = 20 \cos [2\pi f_c t+4\sin 200 \pi t]$.** **Determine the required transmission bandwidth. (Nov/Dec 2017)** Bandwidth = $2(\Delta f + f_m)$ Maximum frequency deviation $\Delta f = m_f * f_m = 4*100=400$ Therefore, BW = 2(400+ 100) = 1 KHz.
23	**Differentiate narrow band FM (NBFM) and Amplitude modulation technique (AM). (Apr/May2017) (Apr/May2018)**
24	**How is narrowband signal distinguished from wideband signal? (Nov/Dec 2017)** The terms "narrowband" and "wideband" refer to the actual radio channel bandwidth. A common definition of narrowband is when 25 kHz or less is used for the radio channel. The benefit of using a narrow channel is the lower noise bandwidth and hence better sensitivity and range. The advantage of wideband is the capability to transfer higher data rates.
25	**What is the need of limiter circuits in FM systems? (Apr/May2018)** FM receivers can be fitted with amplitude limiters to remove amplitude variations caused by noise. The output of the limiter has constant amplitude.
26	**Differentiate coherent and non-coherent systems. (Nov/Dec 2018)** Coherent systems need carrier phase information at the receiver and they

Table for item 23:

AM	Narrow band FM
AM reception is less immune to noise	NBFM is more immune to noise
No frequency deviation	Frequency deviation exists
Amplitude of AM wave varies and is dependent on the modulation index.	frequency of carrier signal varies according to message signal amplitude

	use matched filters to detect and decide what data was sent, while noncoherent systems do not need carrier phase information and use methods like square law to recover the data.
27	**Draw the vector representation of an FM wave. (Nov/Dec 2018)** 
28	**Define transmission bandwidth. (April/May 2019)** Transmission bandwidth is the capacity of a wired or wireless network communications link to transmit the maximum amount of data from one point to another. It is the range of frequencies occupied by the modulated signal.
29	**Draw the schematic diagram to generate FM signal using phase modulator. (Nov/Dec 2019)** 
30	**Let a frequency modulator has frequency deviation of 75 KHz modulates a signal with 15 KHz bandwidth; find the modulated signal bandwidth using Carson's rule. (Nov/Dec 2019)** Bandwidth = 2(maximum frequency deviation + modulating frequency) Bandwidth = 2(75 + 15) KHz=180 KHz
31	**A 25 MHZ carrier is modulated by a 400 HZ sine wave. If the carrier voltage is 4 V and the maximum deviation is 10 KHZ, write the equation of this modulated wave for (i) FM and (ii) PM. (Nov 20, Apr 21)** fc=25MHz; Ac=4V; Δf=10KHz; fm=400Hz; FM: $s(t)= 4 \cos (2\pi x25x10^6t+ (10000/400) \sin (2\pi x400t)) = 4 \cos$

	$(2\pi x25x10^6t+ 25 \sin (2\pi x400t))$ PM: $s(t) = 4 \cos (2\pi x25x10^6t+ 25 \cos (2\pi x400t))$
32	**A 500HZ modulating voltage fed into a FM generator produces a frequency deviation of 2.25 KHZ. What is the modulation index? If the amplitude of the modulating voltage is kept constant, but its frequency is raised to 6 KHZ, what is new deviation? (Nov 20, Apr 21)** Modulation index $\beta=\Delta f/f_m=2.25x10^3/500=4.5$; As the amplitude of the modulating signal is kept constant, there is no change in the deviation.
UNIT II / PART-B	
1	With a neat sketch explain the theory of reactance tube modulator. /Explain with neat diagram the generation of FM using direct method. **(MAY 2015) (April/May2017)**
2	With neat diagrams explain the principle of operation of ratio detector. Compare the merits over the foster- seeley discriminator. **(Nov/Dec 2018) (Nov 20, Apr 21)**
3	Explain the operation of FM slope detectors. **(Nov/Dec 2016)**
4	Elucidate the process of FM demodulation using PLL method. **(April/May2018)**
5	Derive the expression for frequency spectrum of FM modulated signal and comment on the transmission bandwidth**. (Nov/Dec 2018)**.
7	Explain the characteristics and features of demodulation of FM signal with a neat diagram. **(April/May 2019)**
8	(i) Discuss about the need for the frequency translation. (ii) What does PLL consist of? Draw the diagram and explain. **(April/May 2019)**
9	Compare FM and PM system **(April/May 2019)**
10	Derive the spectrum of single tone modulated FM signal and discuss its bandwidth based on Carson's rule and Bessel's function. **(Nov/Dec 19)**
12	With block diagram explain the Armstrong FM Transmitter and discuss its advantages over direct FM transmitters. **(Nov 20, Apr 21)**
13	(i) Differentiate between wideband FM and Narrowband FM. (ii) With a neat sketch, explain any one method of direct FM generation. **(Nov 20, Apr 21)**

UNIT III –RANDOM PROCESS

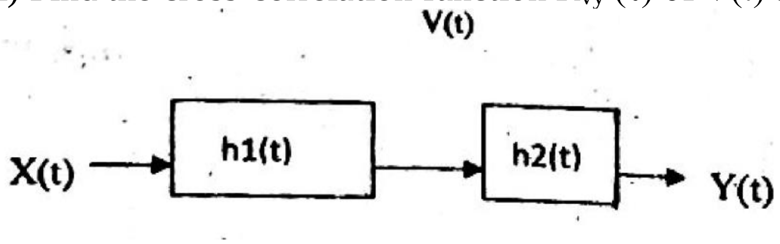
Random variables, Random Process, Stationary Processes, Mean, Correlation & Covariance functions, Power Spectral Density, Ergodic Processes, Gaussian Process, Transmission of a Random Process Through a LTI filter.

UNIT-III/ PART-A

1	**Define probability.** The probability of occurrence of an event A is defined as ratio of number of possible favorable outcomes to the total number of equal likely outcomes.
2	**What are mutually exclusive events?** Two possible outcomes of an experiment are defined as being mutually exclusive if the occurrence of one outcome precludes the occurrence of the other.
3	**Define Random process**. A Random process X (t) is defined as a rule to assign a time function to every outcome of an event.
4	**What is meant by sample space?** The set of all possible outcome of a random experiment is called sample space and is represented by an alphabet‘s’.
5	**What is joint probability?** The probability of an event such as A, B that is intersection of events from sub experiments is called the joint probability of the event.
6	**What is meant by conditional probability?** If A_1, A_2, A_3,…….. and B_1, B_2, B_3,….. are the results of two experiments A and B respectively then probability of occurrence of both A_i and B_j in single experiment is written as $P[A_i , B_j]$ with the probability of A is known , then the $P(B_j/A_i)$ is given by $P\left(\frac{B_j}{A_i}\right) = \frac{N_{ij}}{N} = \frac{P(A_i, B_j)}{P(A_i)}$
7	**What is meant by statistical independence?** A_i and B_j are events associated with the outcome of two experiments. The event B_j is independent of A_i so that occurrence of A_i does not influence the occurrence of B_j and vice versa. Then we say that the events are statistically independent. $P(A_i, B_j) = P(A_i).P(B_j)$
8	**Express random process as a function of random variables.** A random process defined as a function of one or more random variables as $X(t) = g(Y_1,Y_2,….Y_n; t)$ where X(t) is a random process and $Y_1,Y_2,…..Y_n$ are n random variables and g is an ordinary function.
9	**Express mean $\mu_x(t)$ of a statistical average in terms of random process.** The statistical average of a random processes mean $\mu_x(t)$ is defined as $\mu_x(t) = E(X(t))$. The expected values are taken with respect to the appropriate probability density function.
10	**Express auto correlation function in terms of random process./Define autocorrelation function. (May/June 2016)** Auto correlation function R_{xx} (t_1,t_2) is the statistical average of a random processes defined as the expected values of the random processes with

	respect to the appropriate probability density function. $R_{xx}(t_1,t_2) = E(X(t_1),X(t_2))$
11	**When a random process is said to be deterministic? Or When is the random process called as deterministic? (Nov/Dec 2018)** A process is called deterministic, if the future values of any sample function can be predicted from past values. Eg. Consider the random process x(t) = $A\cos(w_0 t)$. In this case, the knowledge of the sample function prior to any time instant automatically allows prediction of the future values of the sample function since its form is known.
12	**Mention any two properties of power spectral density.** i) The PSD of a stationary process is always non-negative. ii) The PSD of a real valued random process is an even function of frequency.
13	**Mention any two properties of Gaussian Process.** i) If a Gaussian process X(t) is applied to a stable filter, then the random process Y(t) developed at the output of the filter is also Gaussian. ii) If a Gaussian process is stationary, then process is strictly Stationary.
14	**Explain the types of random variable with suitable examples.** A random variable may be discrete or continuous. A discrete random variable can take on only a countable number of distinct values. A continuous random variable can assume any value within one or more intervals on the real line.
15	**State the central limit theorem. (May/June 2016) (Nov/Dec 2016) (Nov/Dec 2017)** The central limit theorem states that the distribution of the sum (or average) of a large number of independent, identically distributed variables will be approximately normal, regardless of the underlying distribution
16	**Define a random variable. (Nov/Dec 2015)** Random variable is a rule to assign a real number to every outcome of an experiment. The range is some set of real numbers.
17	**State Bayes rule. (Nov/Dec 2015)** Bayes rule states that $$P\left(\frac{A}{B}\right) = \frac{P(B/A)P(A)}{P(B)}$$
18	**Write Einstein-Wiener – khinchin theorem. (Nov/Dec 2019) (April/May2017)** The Wiener–Khinchin theorem relates the autocorrelation *r* and power spectral density *S* as a Fourier-transform pair, and given by $$S(f) = \int_{-\infty}^{\infty} r_{xx}(\tau) e^{-2\pi i f \tau}\, d\tau.$$
19	**List the sufficient and necessary conditions for the process to be WSS.**

	(April/May2017) If it satisfies the following conditions i)the mean value of the process is a constant E[X(t)] = m = constant. ii)it's autocorrelation function depends only on τ : $E[X(t)X(t+\tau)] = R_{xx}(\tau)$.
20	**What is meant by Ergodic process? (Nov/Dec 2017)** A random process is said to be ergodic process when the time average of a conforming process to equal the ensemble average.
21	**What is the difference between random variables and random process? (April/May 2019)** Random variable is a function from the sample space to real line on the other hand random processes is the mapping from sample space to real functions or waveforms.
22	**When a random process is said to be strict sense or strictly stationary? (April/May 2019)** A random process is called a strongly stationary process or Strict Sense Stationary Process (SSS Process) if all its finite dimensional distribution are invariance under translation of time 't'
23	**Write condition for WSS random signals X(t) and Y(t) to be uncorrelated. (Nov/Dec 2019)** $E[X(t_1)] = E[Y(t_2)]$ $E[X(t_1)\,Y(t_2)] = E[X(t_1)\,Y(t_2+\Delta)]$
24	**Define a random variable. Specify the sample space and the random variable for a coin tossing experiment. (Nov 20/Apr 21)** Random variable is defined as a rule to assign a real number to every outcome of an experiment. For coin tossing experiment, sample space S = {H, T}; X(k) = {0,1}
25	**When a random process is called deterministic? (Nov 20/Apr 21)** A random process is called deterministic if future value of any sample function can be predicted from past values.
	UNIT – III / PARTB
1	(i)Explain the following terms mean, correlation, covariance and ergodicity. **(Nov/Dec 2016) (Nov/Dec 2018)** (ii)How do you represent narrow band noise. **(MAY 2013)**
2	i)Let X and Y be real random variables with finite second moments. Prove the Cauchy- Schwarz inequality $E[XY]^2 \leq E[X^2]E[Y^2]$. ii)Differentiate the strict-sense stationary with that of wide sense stationary process. **(May 2015)**
3	i)Let X(t) and Y(t) be both zero mean and WSS random processes. Consider the random process z(t)= X(t)+Y(t). Determine the autocorrelation and power spectrum of z(t) if X(t) and Y(t) are jointly WSS. ii)Let $X(t)=A\cos(\omega t+\Phi)$ and $Y(t)=A\sin(\omega t+\Phi)$, where A and ω are

	constants and Φ is a uniformly random variable [0,2π]. Find the cross correlation of x(t) and y(t). **(May 2015)**
4	(i) Two random process X(t)= A cos (ωt + Θ) and Y(t)= A sin (ωt + Θ) where ω and A are constants and Θ is uniformly distributed random variable in (0, 2π). Find the cross-correlation function (ii) Explain in detail about the transmission of a random process through a linear time invariant filter**. (May/June 2016)**
5	Consider two linear filter connected in cascade as shown in figure. Let X(t) be a stationary process with a autocorrelation function $R_x(\tau)$, the random process appearing at the first input filter is V(t) and the second filter output is Y(t). **(April/May2017)** (i) Find the autocorrelation function of Y(t). (ii) Find the cross-correlation function R_{vy} (τ) of V(t) and Y(t). 
6	The amplitude modulated signal is defined as $X_{am}(t)=A_m \cos(w_c t+\theta)$ where m(t) is the base band signal and $A_m \cos(w_c t + \theta)$ is the carrier. The baseband signal m(t) is modeled as zero mean stationary random process with the auto correlation function $R_{xx}(\tau)$ and the PSD $G_x(f)$. The carrier amplitude A and the frequency w_c are assumed to be constant and the initial carrier phase θ is assumed to be random uniformly distributed in the interval (-π,π). Furthermore ,M(t), and θ are assumed to be independent. (i) Show that $X_{am}(t)$ is wide sense stationary. **(ii)** Find PSD of $X_{am}(t)$. **(April/May2017)**
7	**i)** Discuss the properties of Gaussian random process**. (Nov/Dec 2017) (April/May2018)** ii)Derive the input and output relationship of a random process applied through a LTI filter. (or) Derive the output expression of a linear time invariant filter**. (Nov/Dec 2018)**
8	**i)** Consider a random process defined as X(t)= A cos ωt , where ω is a constant and A is random uniformly distributed over [0,1]. Find the auto correlation and auto covariance of X(t). **(Nov/Dec 2017)** ii)Distinguish between random variable and random process. Give examples to each.
9	(a) (i) Describe the central limit theorem. (ii) Assume X is Gaussian random variable, find the pdf of the random

	variable y=ax+b, where a and b are constants. **(April/May 2019)** (b)Describe the properties of power spectral density**. (April/May 2019)**
10	A random process x(t) is defined by $x(t)=A\cos(2\pi f_c t)$ where A is a Gaussian distributed random variable of a zero mean and variance σ^2_A.This random process is applied to an ideal integrator, producing the output $y(t)=\int x(\tau)d\tau$ interval 0 to t (a) Determine the pdf of the output y(t) at a particular time t_k. (b)Determine whether or not y(t) is stationary. (c)Determine whether or not y(t) is ergodic. **(April/May 2019)**
11	Consider two WSS processes $X(t) = A\cos(\omega t + \theta)$ and $Y(t) = A\sin(\omega t + \theta)$, where 'A' and 'ω' are constants and 'θ' is uniformly distributed random variable in [-π, π]. Verify their correlation and in-dependence. **(Nov/Dec 2019)**
12	Consider a signal $X(t)= 2\cos(2000\pi t + \theta) + n(t)$ is passed through an ideal low pass filter with bandwidth of 10 KHz. In the signal, 'θ' is uniformly distributed random variable in [-π, π] and n(t) is a normal distributed white noise with power spectral density 10^{-6} W/Hz. (**Nov/Dec 2019**) A. Draw the spectrum of input and output signals of the filter. B. Determine the autocorrelation of input and output signals of the filter. C. Estimate the output signal power.
13	(i)State the properties of a Gaussian process. (ii)For the sine wave process X (t) = Y cos wt, $-\infty < t < \infty$ where ω = constant, the amplitude Y is a random variable with uniform distribution in the interval 0 and 1. Check whether the process is stationary or not. **(Nov 20/Apr 21)**
14	(i)State any four properties of power spectral density. (ii) The ACF of the random telegraph signal process is given by R(t)=e–2λt. Determine the power density spectrum of the random telegraph signal. **(Nov 20/Apr 21)**
15	i)Consider the quadrature amplitude modulated signal. $Y(t)= X(t)\cos w_o t - Z(t)\sin w_o t$, where X(t) and Z(t) are zero mean independent process with identical autocorrelations, $R_x = R_z$. Determine $R_y(t_1,t_2)$ and show that if $R_x(t_1,t_2)=R_x(t_1-t_2)$, then $R_y(t_1,t_2) = R_y(t_1-t_2)$ ii)Discuss the properties of autocorrelation function. **(April/May2018)**

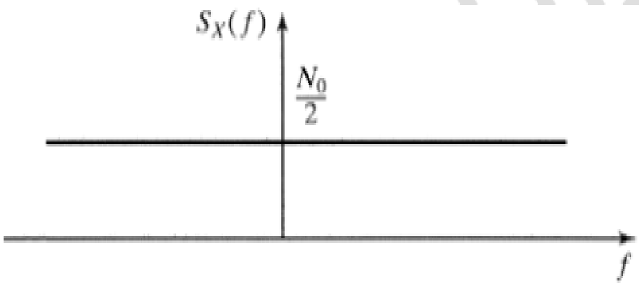
UNIT IV-NOISE CHARACTERIZATION

Noise sources – Noise figure, noise temperature and noise bandwidth – Noise in cascaded systems. Representation of Narrow band noise –In-phase and quadrature, Envelope and Phase – Noise performance analysis in AM-FM systems – Threshold

effect, Pre-emphasis and de-emphasis for FM.	
UNIT-IV / PART-A	
1	**What is pre-emphasis? Why is it needed? (MAY 2015)** Boosting of higher modulating frequencies is called pre-emphasis. It is needed to maintain the signal to noise ratio constant at the FM receiver
2	**State the cause of threshold effect in AM systems? (MAY 2015). (April/May2017)** When the carrier-to-noise ratio at the receiver input of a standard AM is small compared to unity, the noise term dominates, and the performance of the envelope detector changes completely.
3	**What is coherent system? (MAY 2013)** In coherent system, carrier signal is required for the demodulation of the received signal. The carrier signal used at the demodulator should be synchronous (magnitude and phase) with that of the carrier signal used at the modulator.
4	**Give the expression for noise voltage when several sources are cascaded.** Noise voltage can be expressed as, $V_n^2 = \sqrt{4kTB(R_1 + R_2 + \cdots}$ Where R_1 , R_2 --- are the resistances of the noise resistors, K be the Boltzmann constant, T be the absolute temperature and B be the bandwidth.
5	**State the reasons for higher noise in mixers.** Conversion transconductance of mixers is much lower than the transconductance of amplifiers. If image frequency rejection is inadequate, the noise associated with the image frequency also gets accepted.
6	**Define signal to noise ratio.** Signal to noise ratio is the ratio of signal power to noise power at the same point in a system
7	**Define band width improvement factor and noise figure improvement.** Band width improvement factor (BI) is the ratio of RF bandwidth and IF bandwidth. $BI = \frac{RF - BandWidth}{IF - BandWidth}$ Noise figure improvement = 10 log (BI)
8	**Define Noise figure. (Nov/Dec 2015) (Nov/Dec 2016)** Noise figure is a parameter commonly used to indicate the quality of a receiver. Lower the noise figure value better is the performance.
9	**Compare the noise performance of AM receiver with that of DSB-SC or SSB-SC receiver.** The figure of merit of DSB-SC or SSB-SC receiver using coherent detection

	is always unity, the figure of merit of AM receiver using envelope detection is always less than unity. Therefore, noise performance of AM receiver is always inferior to that of DSB- SC due to the wastage of power for transmitting the carrier.
10	**What is capture effect? (May/June 2016)** When the interference signal and FM input are of equal strength, the receiver fluctuates back and forth between them. This phenomenon is known as the capture effect.
11	**What is threshold effect? (Nov/Dec 2015) (Nov/Dec 19)** As the input noise power is increased the carrier to noise ratio is decreased the receiver breaks and as the carrier to noise ratio is reduced further crackling sound is heard and the output SNR cannot be predicted. This phenomenon is known as threshold effect.
12	**What is thermal noise?** Thermal noise is the name given to the electrical noise arising from the random motion of electrons in a conductor.
13	**Give the expression for noise voltage in a resistor.** The mean –square value of thermal noise voltage is given by $V_n^2 = \sqrt{4kTBR}$, where K be the Boltzmann constant, R be the resistance, T be the absolute temperature and B be the bandwidth
14	**What is narrowband noise? (April/May2018)** If the bandwidth of the bandlimited noise is relatively small compared to the carrier frequency, it is referred as narrowband noise.
15	**Give the expression for noise equivalent noise temperature in terms of hypothetical temperature. (May/June 2016) (Nov/Dec 2016)** The expression for equivalent noise temperature in terms of hypothetical temperature is $T_e = (F- 1) T_0$, where F is the noise figure and T_0 absolute temperature.
16	**What is external noise? List the external sources of noise. (Nov/Dec 2017)** External noise is produced by the external sources which may occur in the medium or channel of communication, usually. This noise cannot be completely eliminated. The best way is to avoid the noise from affecting the signal. The external noise sources are atmospheric noise, extraterrestrial noise and man-made noise.
17	**Defend the reason why SNR of the receiver should be high. (April/May2018)** A higher signal to noise ratio indicates more signal than noise. This indicates that system is not much dominated by noise and there exists a best chance of recovering the message signal accurately.
18	**A noisy system has noise factor of 2. Find its noise figure (NF) and noise equivalent temperature. Assume reference temperature is 300K.**

	(Nov/Dec 19) $NF = 10\log_{10}(F) = 10\log_{10}\left(\frac{CNR_{input}}{CNR_{output}}\right)$ NF= 825 Equivalent noise temperature $T_e = T(F-1)$ T_e = 375 K
19	**How does pre-emphasis and de-emphasis process provide overall SNR improvement in FM systems? (April/May2018)** In FM, signals with higher modulation frequencies have lower SNR. In order to compensate this, the high frequency signals are boosted in amplitude at the transmitter section of a communication system prior to the modulation process. That is, the pre-emphasis network allows the high frequency modulating signal to modulate the carrier at higher level, this causes more frequency deviation. De-emphasis is the inverse process of pre-emphasis, used to attenuate the high frequency signal that is boosted at the transmitter section. The deemphasis network at the receiver section restores the original amplitude-frequency characteristics of the information signal.
20	**Define equivalent noise temperature of a system. (April/May 2019)** The equivalent noise temperature of a system is defined as the temperature at which the noise resistor must be maintained so that by connecting this resistor to the input of a noiseless version of the system, it will produce the same amount of noise power at the system output as that produced by the actual system.
21	**Define noise figure.** Noise figure is defined as the ratio of signal to noise power at the input to the signal to noise power at the output. Noise figure is always greater than unity.
22	**What is white noise? Give its characteristics. (Nov 20/ Apr 21)** 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 PSD of white noise is independent of the operating frequency. White noise has zero mean, constant variance, and is uncorrelated in time, has a power spectrum which is uniformly spread across all allowable frequencies.
23	**Define noise equivalent bandwidth. (Nov 20/ Apr 21)** Noise equivalent bandwidth is the bandwidth of a perfect rectangular filter that allows the same amount of power to pass as the cumulative bandwidth of the channel selective filters.
24	**State Friss formula** According to Friss formula, total noise factor for cascaded stages of amplifier is given by $F = F_1 + \frac{F_2 - 1}{G_1} + \frac{F_3 - 1}{G_1 G_2} + - - - -$

	where F_1, F_2 .. and G_1, G_2… are the noise figures and gains of different amplifier stages.
25	**Draw the power spectral density of the white noise.** 
UNIT-IV / PART-B	
1	(i)A mixer stage has a noise figure of 20 dB and this is preceded by an amplifier that has a noise figure of 9 dB and an available power gain of 15 dB. Calculate the overall noise figure referred to the input. (ii) A receiver has a noise figure of 12 dB and it is fed by a low noise amplifier that has a gain of 50 dB and a noise temperature of 90 K. Calculate the noise temperature of the receiver and the overall noise temperature of the receiving system. Take room temperature as 290 K.
2	Consider a message which is a WSS process with the autocorrelation function $R_m(t)$= 16 sin c^2 (10000t). All the realizations of the message process satisfy the condition max|m(t)|=6. This message needs to be transmitted via a channel with a 50 dB attenuation and additive white noise with the power spectrum density Sn(f)=N0/2=10-12 W/Hz. The SNR at the modulator output should be atleast 50 dB. What is the transmitter power and channel bandwidth if the following modulation schemes are employed? (i) DSB – SC AM (ii) SSB – SC AM. (iii) Conventional AM with a modulation index of 0.8. **(Nov/Dec 2015)**
3	Give a detailed account on impact of noise on angle modulation schemes. What is the required received power in an FM system with modulation index, β = 5 if W = 15 kHz and N_o = 10-14 W/Hz? The power of the normalized message signal is assumed to be 0.1 Watt and the required SNR after demodulation is 60 dB. **(Nov/Dec 2015)**
4	**i)** Explain the operation of Pre-emphasis and De-emphasis in FM communication systems. **(Nov/Dec 2017) (Nov 20/ Apr 21)** ii)An amplifier has three stages with gain 5dB, 20dB and 12 db. The noise figures of the stages are 7dB, 13dB and 12 dB respectively. Determine the overall noise figure and the noise equivalent temperature.
5	i)Classify the different types of noise and also comment its cause and effects. **(May2018) (Nov /Dec 2018)** ii)Prove that the random band pass noise signal n(t) can be expressed as n(t)= n_e(t) cosωt + n_s (t) sinωt, where n_e(t) and n_s (t) are low frequency

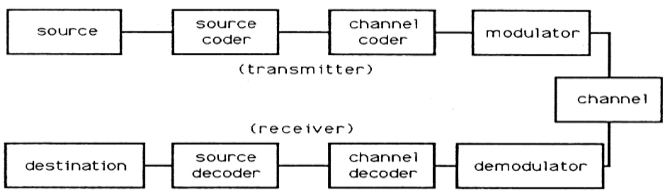
	signal bandlimited to ω_m rad/sec.
6	Obtain an expression for figure of merit for an FM signal, with assumption that the noise added in the channel is additive white Gaussian noise. **(April/May2018)**
7	Compile your favorite song modulate it and favorite it. During the transmission what are the noises may occur and how can you reduce noise at the receiver end. Obtain PSD of your signal. **(Nov /Dec17)**.
8	(i) Discuss about any four properties if in phase and quadrature components of a narrow band noise. (ii) Calculate the noise voltage at the input of a television RF amplifier, using a device that has 200-ohm equivalent noise resistance and 300 ohm input noise resistance. The bandwidth of an amplifier is 6 MHz and the temperature is 17 degree celcius. **(April/May 2019)**
9	Derive the figure of merit (FoM) for envelope detector for AM signal and coherent receivers for DSBSC receivers in the presence of AWGN and comment. **(Nov/Dec 2019)**
10	Discuss PSD of output noise of an FM demodulator in the presence of AWGN at its input and explain the importance of pre-emphasis and de-emphasis circuits in FM system chain. **(Nov/Dec 2019)**
11	Consider an AM signal which is obtained by modulating message m(t) using a carrier signal 5 $\cos(2\pi 10^6 t)$ with sensitivity $3V^{-1}$. Let M(t)=sinc(2000t) V. At the receiver input, the signal is corrupted by a white a noise with PSD of 10^{-6} W/Hz. The received signal is passed through an ideal channel select filter before demodulator. **(Nov/Dec 2019)** i)Find the transfer of the channel select filter. ii) Draw the PSD of signal at receiver input and demodulator input. iii)Calculate the SNR available at the input and output.
12	Define a narrowband noise and explain the representation of narrow band noise in terms of in-phase and quadrature components. (or) Briefly, enumerate on narrow band noise and the properties of quadrature components of narrow band noise (or) What is narrowband noise? Discuss the properties of the quadrature components of a narrowband noise. **(Nov /Dec 2018) (Nov 20/ Apr 21)**

UNIT V SAMPLING & QUANTIZATION

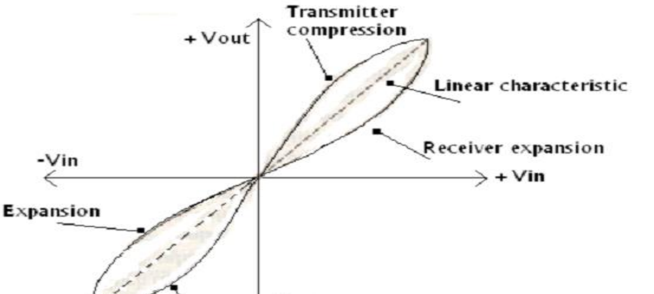
Low pass sampling – Aliasing- Signal Reconstruction-Quantization - Uniform & non-uniform quantization - quantization noise - Logarithmic Commanding –PAM, PPM, PWM, PCM – TDM, FDM.

UNIT-V / PART-A

1	**Mention the advantages of digital communication system over analog communication. (May2013, 2015)**

	i) It gives ruggedness to transmission noise and interference. ii) Efficient regeneration of coded signal along transmission path. iii) Possible to have a uniform format for different kinds of baseband signal.
2	**What are the drawbacks of PPM?** (i)As the position of PPM pulses is varied with reference to a reference pulse, a transmitter has to send synchronizing pulses to operate the timing circuits in the receiver. Without them the demodulation won't be possible to achieve. (ii)Large bandwidth is required to ensure transmission of undistorted pulses.
3	**How do you improve BER in digital communication system? (Dec 2012)** Increasing transmitted signal power, improving frequency filtering techniques, modulation and demodulation, and coding and decoding technique
4	**What are the advantages of PAM?** (i)PAM allows data to be transmitted more effectively, efficiently and quickly using conventional copper wires in greater volume. (ii)The frequency modulations available are infinite; hence PAM formulas can be developed continually to allow increased data throughput over existing networks. (iii)PAM is also the simplest form of modulation.
5.	**What are the advantages of PPM?** (i)Signal and noise separation is very easy (ii)Constant transmitted power output (iii)Require very less power compared to PAM and PDM because of short duration pulse (iv)Highest power efficiency among all three types (v)In PPM, the amplitude is held constant thus less noise interference
6	**Draw the typical digital communication system (Dec 2012)** 
7	**Give the disadvantages of digital communication. (May 2014, 2015)** i) There is high power consumption in digital communication. ii) There is a requirement for synchronization in the case of synchronous modulation. iii) There is a sampling error. iv) The most common limitation of digital communication is that it requires more transmission bandwidth. It is due to the higher data rate because of analog to digital conversion. v) Digital communication requires analog to digital conversion at a high

	rate. vi) There can be a possibility of miscommunication if a user doesn't understand something.
8	**State sampling Theorem. (May 2015, Dec 2015, Nov 20/ Apr 21)** If a finite energy signal g(t) contains no frequency component higher than ω Hz, it is completely determined by specifying its ordinates at a separation of points spaced 1/ 2ω seconds apart. If a finite energy signal g(t) contains no frequency component higher than ω Hz, it is completely recovered from its ordinates at a separation of points spaced 1/ 2ω seconds apart.
9	**What is quantization?** Quantization is the process of mapping continuous amplitude signal into discrete amplitude signal. The analog signal is quantized into countable and discrete levels known as quantization levels. Each of these levels represents a fixed input amplitude. During quantization, the input amplitude is round off to the nearest quantized level. This rounding off is known as quantization error. Quantization error can be reduced by increasing the numbers of quantization levels.
10	**What is pulse modulation?** The parameters of the pulse such as amplitude, position and width of the pulse is varied in accordance to the sampled value of the signal.
11	**What is Quantization Noise? (Dec 2017)** The difference between the input analog sample and the discrete quantized output signal gives rise to an error called Quantization Noise.
12	**What are the corrective measures taken to avoid aliasing effect?** A low pass anti-alias filter is used to attenuate high frequency of the signal that lie outside the frequency band of interest prior to sampling. The filtered signal is sampled at a slightly higher rate than nyquist rate
13	**What is the need for non-uniform quantization? (May 2014)** In uniform quantization, the step size remains the same throughout the range of quantizer. For the low signal amplitude, the maximum quantization error is quite high. But for high amplitude, the maximum quantization error is small. This problem arises because of uniform quantization. As a result, the step size needs to be a varied according to the signal level to keep SNR at the required value. This is achieved by non-uniform quantization
14	**What is Companding? Sketch the input-output characteristics of a compressor and an expander (May 2016, Dec 2016, May 2017)** Companding is the combined process of compressing and expanding used for improving the dynamic range of signal and also to increase the SNR of low-level signals.



15	**Write the A law Compression. (Nov 2013)** $Z(m) = \frac{A\|m\|}{1+\ln A}$ **for 0≤m≤1/A** $\frac{1+\ln(A\|m\|}{1+\ln A}$ **for 1/A≤ $\|m\|$ ≤1**
16	**What is aliasing? (May 2016, Dec 2016))** Aliasing effect takes place when sampling frequency is less than the 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 component is called aliasing effect.
17	**What are the two-fold effects of quantizing process? (Dec 2015)** (a) The peak-to-peak range of input sample values subdivided into a finite set of decision levels or decision thresholds. (b) 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.
18	**Define non-uniform quantization. (May 2015)** The step size of the quantizer increases as the separation from the origin of the transfer characteristics increases. The SNR will be maintained constant in the wide range of input power levels.
19	**A PCM system uses a uniform quantizer followed by a 7-bit binary encoder. The bit rate of system is 50 x10⁶ bits/sec. What is the maximum message BW for which the system operates satisfactorily? What is the SNR for a full load sinusoidal signal? (Dec 2017)** $2f_mN = 50 \times 10^{6;}$ $2f_m \times 7 = 50 \times 10^{6;}$ $f_m = 50 \times 10^6/14 = 3.57$ MHz; SNR = 1.8 + 6N = 43.8 dB
20	**What do you mean by sampling rate? (April/May 2019)** Sampling rate or sampling frequency defines the number of samples taken per second taken from a continuous signal to make a discrete or digital signal.

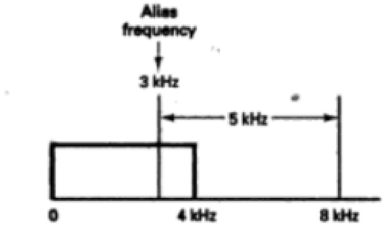
21 **How multiplexing of digital signals can be accomplished? (April/May 2019)**

Multiplexing combines multiple analog or digital signals bound for transmission through a single communication line or computer channel. This technique has been introduced to increase channel utilization in multicomputer communication systems and time-sharing systems and also to reduce the communication cost.

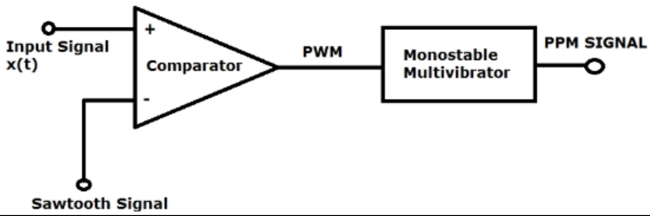
22 **For a PCM system with maximum audio input frequency of 4KhZ, determine the minimum sample rate and alias frequency produced if a 5 KhZ audio were allowed to enter the sampling circuit. (Nov 20/ Apr 21)**

minimum sampling rate = 2 x maximum signal freqency = 2 x 4 = 8 KHz

Aliased frequency = │8Khz-5Khz │=3 Khz



23 **Draw the schematic diagram to generate PPM signal from PWM signal (Nov/Dec 19)**



24 **In a pulse code modulator, 6-bit encoder has been replaced by a 8 bit encoder. Calculate the SNR improvement offered by the replacement. (Nov/Dec 19)**

For increase in each bit of encoder, the SNR will increase by 6dB.

So with reference to the question given, SNR will improve by 12dB

25 **What is TDM and FDM?**

Time division multiplexing (TDM) is the method of transmitting more than one message signal through a common channel that are separated in time. Frequency division multiplexing (FDM) is the method of transmitting more than one message signal through a common channel that are separated in frequency.

UNIT-V / PART-B

1 Derive an expression for signal to quantization noise ratio of Uniform quantizer.
(Nov 2013, Dec 2017)

2.	i) Explain Uniform Quantization in detail with its types. (**Dec 2016)** ii) Discuss the necessity for Non-Uniform Quantization of speech signal. **(May 2014)**
3	i) Derive the expression for quantization noise of a PCM system with uniform quantizer. Explain how it can be improved. **(May 2013)** ii) A sinusoidal signal is transmitted using PCM. An output SNR if 55.8 dB is required. Find the number of representation levels required? iii) Explain how PCM is influenced by noise sources.
4	Draw and explain the TDM with its applications **(Dec 2016, May 2017)**
5	(i) Explain the working of PWM with a neat sketch. (ii)Write down the corrective measures to combat the effects of aliasing. **(April/May 2019)**
6	(i)Write the advantages and some of the applications of PCM system. (ii) Briefly describe the concept of FDM. **(April/May 2019)**
7	Discuss on distribution of quantization errors in uniform quantizes and derive the relationship between number of bits used in the encoder and signal to quantization noise ratio. (**Nov/Dec 2019**)
8	Draw the block diagram of a pulse code modulation system and discuss the design consideration of each block. (**Nov/Dec 2019**)
9	What is quantization? Explain in detail about the uniform and non-uniform quantization. **(Nov 20/Apr 21)**
10	Draw the block diagram and explain the process of a PCM system in detail. **(Dec 2015) (Nov 20/Apr 21)**
11	Draw and explain the concept of FDM with its applications.
12	Explain the generation and detection PPM in detail
13	Explain the generation and detection PWM in detail