EC 8491- COMMUNICATION THEORY (Regulation 2017)

UNIT 1

PART-A

1. **What are the advantages of converting low frequency signal to high frequency signal? Nov 2016**

   Ease of transmission, Multiplexing, Reduced noise , Narrow bandwidth Frequency assignment and Reduce the equipments limitations.

2. **Suggest a modulation scheme for the broadcast video transmission and justify. Nov 2016**

   VSB i.e. Vestigal Sideband Modulation is usedfor TV transmission. Vestige means "PART". The part of side band is used to transmit the video signal and the remaining is
   used for transmitting the voice signal.

3. **Define modulation index of AM. Nov 2014**

   In AM wave, the modulation index (m_a) is defined as the ratio of maximum amplitude of modulating signal to the maximum amplitude of carrier signal.

   $$m_a = V_m/V_c$$

4. **Compare linear and non linear modulators. May 2015**

Linear modulators	**Non-linear modulators**
1. Heavy filtering is not required.	1.Heavy filtering is required
2. These modulators are used in high level modulation.	2.These modulators are used in low level Modulation.
3. The carrier voltage is very much greater than modulating signal voltage.	3.The modulating signal voltage is very much greater than the carrier signal voltage.

5. **What are the methods used to generate the SSB-SC-AM?**

   SSB-SC-AM waves can be generated in to two ways,

   (i) Frequency discriminator or Filter method
   (ii) Phase discriminator method

   Phase discriminator method itself can be divided in to two types.

   (i) Phase shift method
   (ii) Modified phase shift method or Weavers method

6. What is VSB? Where it is used? (Nov/Dec-2017)

Vestigial Sideband Transmission (VSB) 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. Portion of one of the redundant sidebands are removed and vestige (portion) of the other sideband is transmitted to form a Vestigial Sideband signal. Uses of VSB: VSB modulation has become standard for the transmission of Television signals.• VSB is used for TV picture broadcasting

6. Distinguish between single sideband and Double sideband.

Parameter	Single Side Band (SSB)	Double Side Band (DSB)
Bandwidth	f_m	$2f_m$
Power saving for sinusoidal	83.3%	66.66%
Power saving for non-sinusoidal	75%	50%
Generation methods	More difficult	Not difficult
Detection methods	More difficult	Difficult
Sidebands	One sideband	Double sideband
Application	Long range high frequency communication, especially in audio communication	Short distance point to point communication

7. Define modulation and mention its types.

Modulation is defined as the process by which some parameter (amplitude, frequency or phase) of a high frequency signal termed as carrier is varied in accordance with the information signal.

(i) Analog modulation – Continuous and pulse modulation

(ii) Digital modulation

8. What is pre-envelope and complex envelope? May 2016

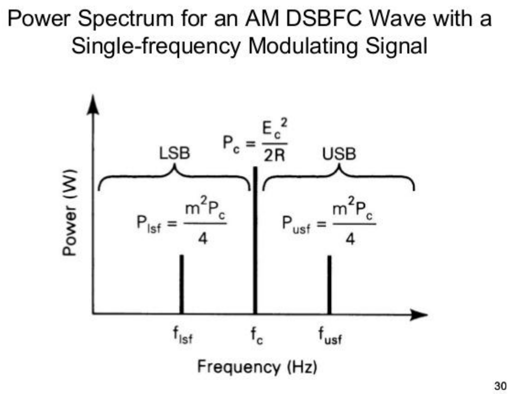
An analytic signal is a complex signal created by taking a signal and then adding in quadrature its Hilbert Transform. It is also called the pre-envelope of the real signal.

Analytic signals are often shifted in frequency (down-converted) toward 0 Hz, possibly creating [non-symmetrical] negative frequency components is called complex envelope.

9. Name the advantage of modulation.

Ease of transmission, Multiplexing, Reduced noise , Narrow bandwidth Frequency assignment and Reduce the equipments limitations.

10. Draw the power spectrum of AM. May 2015



11. Mention the relationship between carrier power and total power.

$P_t = P_c\,(1+ma^2/2)$

Where, P_t - Total power of the modulated wave

P_c - Carrier power

m_a - Modulation index

12. Compare low level and high level modulation.

Low Level Modulation: 1. The generation of AM wave take place at a low power level.

2. With low level modulation, the modulation takes place prior to the output element of the final stage of transmitter. 3. The linear amplifiers are required in order to avoid any waveform distortion.

High Level Modulation: 1. In this method, the generation of AM wave take place at high power levels. 2. The carrier and the modulating signal both are amplified first to an adequate power level and the modulation takes place in the last RF amplifier stage of the transmitter.

13. List some application of SSB in AM? May 2017

1. Point to point radio telephone communication
2. SSB telegraph system
3. Police wireless communication
4. UHF and VHF communication

14. Determine the Hilbert transform of cosωt. (Nov/Dec-2017)

Hilbert transform shifts the phase of positive frequency components by -90° and that of negative frequency components by +90°. Thus, the Hilbert transform of cosωt is sinωt. H[cosωt] = sinωt.

15. Does the modulation technique decide the antenna height? (APR/MAY– 2017)

Yes. For the transmission of radio signals, the antenna height must be multiple of λ/10.

λ = c /f where λ is the wavelength, c is the velocity of light and f is the frequency of the signal to be transmitted.

16.Define carrier swing. (APR/MAY– 2017)

Carrier Swing (CS) is defined as the total variation in frequency from lowest to highest point. Carrier Swing = 2* frequency deviation of the FM signal = 2* $\Delta\omega$

17.What theorem is used to calculate the average power of a periodic signal gp(t)? State the theorem. (MAY/JUNE – 2016) (or) The average power of a periodic signal gp(t) is calculated using what theorem? State the theorem. (NOV/DEC – 2013) (or) State Parseval's theorem. (MAY/JUNE – 2011)

The average power of a periodic signal gp(t) is calculated using Parseval's theorem. It states that if x(t) is the periodic power signal with Fourier coefficient X(k), then average power in the signal is given by

$$Gp(t)=\Sigma| X(k)|2$$

18. State the differences between single side band and vestigial side band transmission systems. (MAY/JUNE – 2014)

S. No.	Single Sideband transmission	Vestigial Sideband transmission
1.	Only one sideband is transmitted.	In VSB modulation, one sideband is passed almost completely whereas just a trace or vestige of the other sideband is transmitted.
2.	Frequencies near edge are attenuated.	Frequencies near edge are not attenuated.
3.	Bandwidth (BW) is f_m	f_m< BW < $2f_m$
4.	Transmission Efficiency (η) is 83%	33.3% < η < 100%
5.	It is used in Two way radio Communication and military communications.	It is used for transmitting Television signals.

19.For an AM system, the instantaneous values of carrier and modulating signal are 60sinωct and

40sinωct respectively. Determine the modulation index. (MAY/JUNE – 2014)

Solution:

Given e_c= 60sinω_ct and e_m = 40sinω_mt

Compare the given signals with standard AM

equations, $e_c = E_c \sin\omega_c t$ and $e_m = E_m \sin\omega_m t$

$E_c = 60$ V and $E_m = 40$ V

Modulation index, $m = E_m / E_c = 40 / 60 = 0.6667$.

20.Define sensitivity characteristics of a radio receiver. (MAY/JUNE – 2014)

The ability of the receiver to pick up weak signals and amplify them is called sensitivity. It is often defined in terms of voltage that must be applied to the receiver input terminals to give the standard output power measured at output terminals.

PART-B

1. Derive the expression for amplitude modulated and explain any one method to generate and demodulate it. **Nov'16, May'14**
2. Explain the operation of balanced modulator to generate DSB-SC-AM.**May'16, Nov'16**
3. With a neat block diagram explain the super heterodyne receiver and its performance. **May'17, May'16, Nov'15, May'15, May'14, May'11**
4. Explain the filter and phase shift method to generate SSB-SC-AM generation.
5. Derive the expression for envelope waveform for AM and calculate power, current, efficiency for the modulated wave. **Nov'16, May'14**
6. Explain the operation of envelope detector with a neat waveform. **Nov'15, May'15, May'11**
7. Derive the expression for SSB-SC and calculate power, current and efficiency. **May'15**
8. Explain any two methods to generate DSB-SC-AM in detail. **Nov'15**
9. With a neat block diagram explain the modified phase shift method or weavers method to generate SSB.
10. Explain the operation of balanced modulator and ring modulator to generate DSB.

11. What is the need for VSB? Explain the generation of VSB (Filter method) and give its advantage and application. **May'17**

12. Comparison of Amplitude Modulation system with AM, DSB, SSB and VSB.

Nov'14

UNIT 2
PART-A

1. **Define modulation index of frequency modulation. Nov'16**

Modulation index of FM is defined as the ratio of frequency deviation to modulating frequency.

m_f = frequency deviation / modulating frequency

In FM, the modulation index is directly proportional to the amplitude of the modulating signal and inversely proportional to the frequency of the modulating signal.

$m_f = \Delta f / fm = K_f V_m / f_m$

m_f – Modulation index (unitless)

K_f – Deviation sensitivity (radians per second per volts)

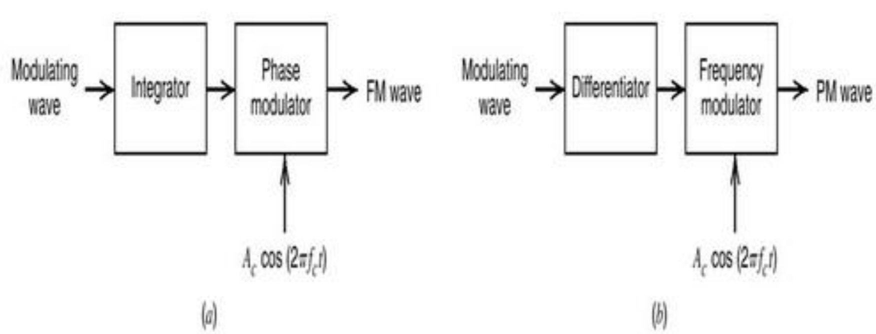
V_m - Peak modulating signal amplitude (volts)

f_m - Maximum frequency of modulating signal

2. **Name the methods of detecting FM signal.**
   1. Slope detector – Single tuned and stagger tuned discriminator
   2. Phase discriminator – Foster –seeley and Ratio detector

3. **Illustrate relationship between FM and PM, with block diagrams. May'15**

Relationship between FM and PM.
(a) FM scheme by using a phase modulator.
(b) PM scheme by using a frequency modulator.



4. **State carson's rule. Nov'15**

Carson's rule approximates the bandwidth necessary to transmit and angle modulated wave as twice the sum of the peak frequency deviation and the highest modulating signal frequency.

$BW = 2(\Delta f + f_m)$ Hz

Where, Δf – Peak frequency deviation, fm – Modulating signal frequency

5. List the properties of Bessel's function. Nov'14

(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 $J_0(\beta)=1$

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

$J_n(\beta)=0, n>2.$

(iii) $\Sigma J^2_n(\beta)=1$

6. Define phase locked loop.

A phase-locked loop (PLL) is an electronic circuit with a voltage or voltage-driven oscillator that constantly adjusts to match the frequency of an input signal. PLLs are used to generate, stabilize, modulate, demodulate, filter or recover a signal from a "noisy" communications channel where data has been interrupted.

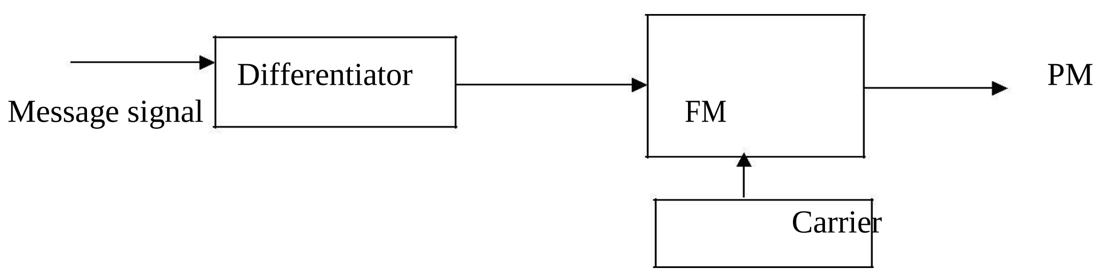
7. What is the disadvantage of balanced slope detector? Nov'14

(i) Even though linearity is good, it is not good enough.

(ii) It is difficult to tune since the three tuned circuits are to be tuned at different frequencies.

(iii) Amplitude limiting is not provided.

8. How FM can converted to PM wave. May'17



9. Compare NBFM and WBFM. May'11

WBFM	NBFM
Modulation index is greater than 1	Modulation index less than 1
Frequency deviation 75 KHz	Frequency deviation 5 KHz
Bandwidth 15 times NBFM	Bandwidth $2f_m$
Noise is more suppressed	Less suppressing of noise

10. Give the transmission bandwidth required for FM.

For narrow band FM is same as that of AM, which is equal to twice of modulating frequency. $BW = 2f_m$ Hz

For wide band FM, the BW = $2\Delta f$

11. Define frequency deviation.

In FM, the deviation (Δf) is defined as the amount by which the carrier frequency is varied from its unmodulated value. The magnitude of the frequency and phase deviation is proportional to the amplitude of the modulating signal. (V_m)

$\Delta f = K_f V_m$ (Hz)

12. What are angle modulation and its types? Nov'15

In angle modulation, the timing parameters such as phase or frequency of the carrier are modulated according to amplitude of modulating signal.

(i) Frequency modulation

(ii) Phase modulation

13. What are the two methods to producing FM signal? May'11

(i) Direct method – Reactance modulators and Varactor diode modulators

(ii) Indirect method – Armstrong method

14. Define the modulation index of PM.

In PM, the modulation index is proportional to the amplitude of the modulating signal, independent of its frequency.

$m_p = K_p V_m$ (radians)

Where K_p – Deviation sensitivity (radians/volt) V_m – Peak modulating signal amplitude(volt)

15. How is the narrowband FM converted into wideband FM? (NOV/DEC – 2012, NOV/DEC– 2011)

The narrowband FM signal can be converted into wideband FM signal by simply passing it through a non–linear device with power P. Both the carrier frequency and frequency deviation Δf of the narrowband signal are increased by a factor P.

16. What is meant by detection? Name the methods for detecting FM signals. (MAY/JUNE –2012, MAY/JUNE – 2011)

Detection is the process of obtaining modulating signal back from modulated signal. The detection is performed at the receiver.

Methods of FM detection:

i. Balanced slope or frequency discriminator ii. Ii. Foster – Seeley or phase discriminator

iii. Ratio detector

iv. PLL demodulator

17.What are the advantages of ratio detector? (NOV/DEC – 2011)

- Ratio detector has wider bandwidth.
- Provides a good level of immunity to amplitude noise.
- Very good linearity due to linear phase relationship between primary and secondary windings.

18.What do you understand by FM stereo multiplexing? (MAY/JUNE – 2009)

Stereo multiplexing is a form of frequency division multiplexing designed to transmit two separate signals via the same carrier. It is widely used in the FM radio broadcasting to send two different elements of a program.

The two important factors that influence the FM stereo transmission are:

- The transmission has to operate within the allocated FM broadcast channels.
- It has to be compatible with the monophonic receivers.

19.What is the purpose of limiter in FM receiver?

Limiter is present before demodulator in FM receiver. The purpose of the limiter is to provide a constant level of signal to the FM demodulator, thus reducing the effect of signal level changes in the output. For instance, if two or more signals are received at the same time, a high performance limiter stage can greatly reduce the effect of the weaker signals on the output. The limiter also reduces the effect of noise spikes.

20.Write the expression for spectrum of a single tone FM signal.

When the carrier is frequency modulated by a modulating signal $\cos\omega_m t$, then the FM signal is represented using Bessel functions as follows:

$$e_{FM}(t) = E_c \{J_0 \sin \omega_c t + J_1 [\sin (\omega_c + \omega_m) t - \sin (\omega_c - \omega_m) t]$$
$$+ J_2 [\sin (\omega_c + 2\omega_m) t + \sin (\omega_c - 2\omega_m) t]$$
$$+ J_3 [\sin (\omega_c + 3\omega_m) t - \sin (\omega_c - 3\omega_m) t]$$
$$+ J_4 [\sin (\omega_c + 4\omega_m) t + \sin (\omega_c - 4\omega_m) t] + \ldots\}$$

Here $J_0, J_1, J_2, \ldots$ are the Bessel functions and E_c is the amplitude of carrier signal.

PART-B

1. Derive an expression for a single tone FM signal with necessary diagram and draw its frequency spectrum. **Nov'16, May'16, Nov'15, May'11**

2. Explain the direct method of FM generation. **Nov'16, May'15**

3. Explain the Armstrong method of FM generation with a neat diagram. **May'16, 14**

4. With a neat diagram explain the operation of slope detector of frequency modulation. **May'11**

5. An angle modulated wave is $V(t)=100 \, Cos(2*10^6 \, \Pi t + 10 \, Cos \, 2000 \, \Pi t)$. Find power of modulating signal, bandwidth and maximum frequency deviation. **May'16, 15, 11**

6. Explain the function of any FM detector circuit. **May'14**

7. Explain the working operation of balanced slope detector. **May'11**

8. Derive the expression for frequency modulation and phase modulation with a neat waveform.

9. Write about the basic principle of FM detection and explain about ratio detector. **Nov'16**

10. Draw the circuit diagram of foster seelay discriminator and explain its working with relevant phasor diagram. **May'16, Nov'15, May'15**

11. Derive the expression for NBWM and WBFM and compare it.

12. Make atleast 10 comparison of AM and FM system. **May'14**

UNIT 3

PART-A

1. State central limit theorem. Nov'16

It provides mathematical justification for using Gaussian process for large number of individual random events.

Requirements:

i) Xi are statistically independent.

ii) Xi have some probability distribution with mean μx and variance σx^2.

2. Write Einstein weiner khintchine relation. Nov'16

a) $Sx(f) = \int Rx(\tau) exp(-j2\Pi f \tau) d\tau$

b)Rx(τ)=∫ Sx(f)exp(-j2Πf τ)d τ

3. What is auto correlation function? May’16

The auto correlation function of the process X(t) is the expectation of the product of two random variables X(t1) and X(t2) obtained by observing the process X(t) at times t1 and t2.

Rx (t1, t2) = E[X(t1).X(t2)]

$$=\iint x1x2fx(t1)x(t2)(x1,x2)dx1dx2$$

4. Define random variable. Nov’15

Random variable is defined as a rule or mapping from the original sample space to a numerical sample space subjected to certain constraints. Random variable is also defined as a function where domain is the set of outcomes ωεs and whose range is R, is the real line.

5. List out the condition for a process to be ergodic in mean.

The time average µx(T) approaches the ensemble average µx when observation interval T approaches infinity. $\lim_{T\to\infty} \mu x(T) = \mu x$

The variance of µx(T) approaches zero when the observation interval T approaches infinity.

$$\lim_{T\to\infty} Var[\mu x(T)] = 0$$

6. What is shot noise? May’15

These Noise are generally arises in the active devices due to the random behaviour of Charge particles or carries. In case of electron tube, shot Noise is produces due to the random emission of electron form cathodes.

7. List out the property of power spectral density. Nov’15

(i) The PSD of a stationary process for zero frequency value is equal to the total area under the graph of auto correlation function.

(ii) The mean square value of a stationary process equals the total area under the graph of the PSD.

(iii) PSD of a stationary process is always non negative.

(iv) PSD of a read valued random process is an even function of frequency.

(v) The PSD, approximately normalized has the properties usually associated with a probability density function.

8. List out the condition for a process to be ergodic in auto correlation function.σ

$$\lim_{T\to\infty} Rx(\tau,T) = Rx(\tau)$$

$$\lim_{T\to\infty} Var[Rx(\tau,T)] = 0$$

9. Define ergodic random process. May’13

A random process is said to be ergodic if the time averages of the process are equal to the ensemble averages.

10. What is Gaussian random variable?

X(t) is said to be Gaussian process if every linear functional of X(t) is a Gaussian random variable.

Probability density function of Y can be given as

$$f_Y(y)=\frac{1}{\sqrt{2\pi}}\frac{1}{\sigma y}exp_{2\sigma 2y}^{(y-?x)2}$$

11. Write the formula for cross correlation.

The cross correlation function of X(t) and Y(t) are defined by

R_{XY} (t,u) = E[X(t) . Y(u)] (or)

R_{YX} (t,u) = E[Y(t) . X(u)]

12. What is central limit theorem? May'16

It provides mathematical justification for using Gaussian process for large number of individual random events.

Requirements:

i) Xi are statistically independent.

ii) Xi have some probability distribution with mean µx and variance σx^2.

13. Define stationary process. May'11

The statistical characterization of a process is independent of time at which observation of the process is initiated. If such a process is divided in to number of time interval, the various section of the process exhibit same statistical properties. Such a process is said to be stationary process.

14. List out the properties of correlation function.

(i) Cross correlation is not an even function.

(ii) It does not have its maximum at origin.

(iii) It does obey a certain symmetry relationship as follows $R_{XY}(\tau) = R_{YX}(-\tau)$

15.Define jointly Wide Sense Stationary processes.

The two processes X(t) and Y(t) are called jointly Wide Sense Stationary if each of X(t) and

Y(t) is Wide Sense Stationary (WSS) and their cross-correlation depends only upon time

difference τ. (i.e.,)

$$R_{XY}(t, t+\tau) = E[X(t)\, Y(t+\tau)] = R_{XY}(\tau)$$

Where $R_{XY}(t, t+\tau)$ and $R_{XY}(\tau)$ are crosscorrelation functions.

16. Difference between SSS and WSS processes.

S. No.	Strict Sense Stationary (SSS) process	Wide Sense Stationary (WSS) process
1.	All statistical properties do not change with time.	Mean and autocorrelation do not change with time.
2.	Ideally, this process does not have start and end.	This process does have start and end at finite times.
3.	Such processes are not physically possible.	Such processes are physically possible.

4.	It appears stationary at all the times.	It appears stationary over certain period of time.

17.Define WSS.

A random process is said to be Wide Sense Stationary or Weak Sense Stationary (WSS), if it's

mean and autocorrelation functions are independent of shift of time origin.

18.List the necessary and sufficient conditions for the process to be WSS.

(MAY/JUNE – 2017)

A process X(t) is Wide-Sense Stationary (WSS) if the following conditions are satisfied:

- Mean of random process is equal to the expected value of random process. $m_X(t) = E[X(t)]$ is independent of t.
- Autocorrelation $R_X(t_1, t_2)$ depends only on the time difference $\tau = t_1 - t_2$ and not on t_1 and t_2 individually.

19.When the random process is said to be strict sense or strictly stationary?

(MAY/JUNE – 2011)

The random process is said to be strict sense or strictly stationary when

i. All the statistical properties do not change with shift of time origin.

ii. A truly stationary process should start at $t = -\infty$ and should not stop till $t = +\infty$.

20. State the properties of autocorrelation function.

- The autocorrelation function is an even function of τ. (i.e.,) $R_X(\tau) = R_X(-\tau)$
- The autocorrelation function has its maximum value of $\tau = 0$ (i.e.,) $|R_X(\tau)| \leq R_X(0)$
- The autocorrelation function shows conjugate symmetry.

PART-B

1. Give a random process X(t)=A Cos(ωt+ μ) where A and ω are constants and μ is a uniform distribution random variable. Show that X(t) is ergodic in both mean and auto correlation. **May'16**
2. Explain in detail about the transmission of a random process through a linear time invariant filter. **May'16, Nov'16**
3. What is gaussian random process and mention its properties. **Nov'16, May'14**

4. When random process is said to be SSS, WSS and ergodic process. **Nov'16, May'16, May'15**
5. Explain about central limit theorem in detail. **May'12**
6. Define the term mean, correlation, covariance and ergodicity. **Nov'16**
7. Two random process x(t)=A Cos(ωt+θ) and y(t)=A Sin(ωt+ θ) where A and ω are constants and θ is uniformly distributed random variable in (0, 2Π). Find the cross correlation function. **May'16, 15**
8. Define auto correlation and prove the auto correlation properties.
9. Explain in detail about the transmission of a random process through LTI filter. **May'16**
10. When random process is said to be ergodic and wide sense stationary process. **Nov'15, May'15**
11. Define PSD. Prove the properties of power spectral density. **Nov'15**
12. State and prove the central limit theorem.

UNIT 4
PART-A

1. Define the term noise equivalent temperature. (Nov/Dec – 2017)

The equivalent noise temperature of a system is defined as the temperature at which a noisy resistor has to be maintained such that, by connecting the resistor to the input of a noiseless version of the system; it produces the same available noise power at the system output as that produced by all the sources of noise in the actual system. Noise Equivalent Temperature is denoted by T_e. Thus, $T_e = (F – 1) T$

Where F is the noise factor and T is the temperature in Kelvin

2. Define noise figure. Nov'16,15

It is ratio of the total noise power spectral density (S_{no}) at the output of the two port network to the noise power spectral density (s'_{no}) at the output, assuming the network is noiseless.

3. Give the definition of noise equivalent temperature. May'16

Noise equivalent temperature of a cascade system T_e is given as,

$T_e = T_{e1} + T_{e2} / G_{a1}$ or

Pn=KTeB
KTeB= (F-1)KTb
Te=(F-1)T.

4. **Compare noise performance of DSBSC receiver using coherent detection with AM receiver using envelope detection.**

   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.

5. **List out the various sources of noise.**

   Noise source – External and Internal noise
   External noise – Natural noise and manmade noise
   Internal noise – Thermal noise, shot noise, partition noise, flickering noise, low frequency noise

6. **What is threshold effect? Nov'15, May'15**

   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 by the equation. This phenomenon is known as threshold effect.

7. **Define Thermal noise. May'11**

   This is the electrical noise which is arising from the random motion of electron in a conductor is called thermal noise.

8. **What is capture effect in FM? May'16**

   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.

9. **Define noise figure and express in equation. Nov'15**

   It is ratio of the total noise power spectral density (S_{no}) at the output of the two port network to the noise power spectral density (s'_{no}) at the output, assuming the network is noiseless. It is expressed in terms of equation as,

   In terms of temperature $F = 1+T_e/T$

10. **What are the methods to improve FM threshold reduction? May'11**

    1. Pre-emphasis and de-emphasis.
    2. FMFB (Frequency modulation with feedback)

11. **List out the properties of inphase and quadrature phase components of narrow band noise.**

    (i) $n_I(t)$ and $n_Q(t)$ have zero mean.
    (ii) If n(t) is Gaussian, $n_I(t)$ and $n_Q(t)$ are jointly Gaussian.

(iii) If n(t) is stationary, $n_I(t)$ and $n_Q(t)$ are jointly stationary

(iv) $n_I(t)$ and $n_Q(t)$ have same variance as n(t)

12. What is Figure Of Merit?

Figure of merit is defined as 'the ratio of output signal to noise ratio to channel signal to noise ratio of the receiver'.

$\gamma = (SNR)_o / (SNR)_c$

13. Why the AM figure of merit is always less than 1?

The figure of merit of an AM receiver using envelope detection is always less than unity. This is due to the wastage of transmitting power, which results from transmitting the carrier as a component of the AM wave.

14. Define narrow band noise.

In most communication system we often dealing with band pass filtering of signals. The band pass filters have narrow bandwidths in the sense that bandwidth is small as compared to center frequency. We refer output of this kind of band pass filter as narrow band noise.

15. How will you define the narrowband noise n(t) at the IF filter output in terms of its inphase and quadrature components? (NOV/DEC – 2013)

The narrowband noise n(t) at the IF filter output in terms of inphase and quadrature components is,

$n(t) = n_c(t) \cos(2\pi f_o t) - n_s(t) \sin(2\pi f_o t)$

Here $n_c(t)$ and $n_s(t)$ are inphase and quadrature components.

16.Determine the range of tuning of a local oscillator of a Super Heterodyne receiver when fLO>fC. The broadcast frequency range is 540 Hz to 1600 Hz. Assume fIF = 455 kHz. (MAY/JUNE – 2012)

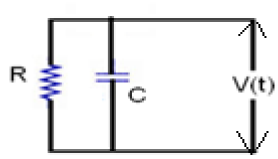
Solution: Given f_c = 540 Hz to 1600 Hz, f_{IF} = 455 kHz.

For $f_{LO}>f_C$ (High-side tuning), $f_{Lo} = f_c + f_{IF}$ = (540 Hz to 1600 Hz) + 455 kHz

$= (540 + 455 *10^3)$ to $(1600 + 455 *10^3)$ = (455.54 to 456.6) kHz.

17.Calculate thermal noise voltage across the simple RC circuit shown with R = 1 kΩ and C = 1

μF at T = 27oC. (NOV/DEC – 2012)



Solution: Given $k = 1.38 \times 10^{-23}$ J/ ^{o}K, C = 1 μF, T = 27 + 273 = 300^{o} K,

18.Give the characteristics of Shot Noise. (MAY/JUNE - 2009)

- Shot noise is generated due to fluctuations in the number of electrons or holes.
- Shot noise has uniform spectral density.
- Mean square noise current depends upon direct component of current.
- Shot noise depends upon operating conditions of the device.

19.Define flicker noise.

Flicker noise or 1/f noise is a form of electronic noise that dominates at low frequencies or low frequency offsets from oscillators. Flicker noise has a 1/f characteristic, or a "pink noise" power density spectrum. Flicker noise occurs in almost all electronic devices.

20.Define figure of merit of AM receiver.

Figure of Merit of AM receiver is given as

FOM=$k_a^2P/1+ k_a^2P$

ka is percentage modulation and P is the average power of message signal.

PART-B

1. Derive the figure of merit for AM system. Assume Coherent detection. **Nov'16**
2. Explain the noise in FM receiver and calculate the figure of merit. **Nov'16**
3. Explain the envelope detection of AM system and calculate FOM. **May'15**
4. Derive the formula for noise figure and noise temperature.
5. Discuss about narrow band noise interms of inphase and quadrature noise components. **May'16, 11**
6. Explain about pre-emphasis and de-emphasis in detail. **May'16, 14**
7. Explain the noise in DSB-SC receiver using synchronous or coherent detection and calculate Figure of merit. **May'17, 16, 15, 11**
8. Derive the figure of merit for a non coherent detection receiver system noise performance of AM. **May'15, 17**
9. Discuss about pre-emphasis and De-emphasis in detail. **May'16, 14**

10. Explain the noise performance of FM system and calculate the figure of merit. **Nov'16**

11. Define noise and explain the various sources of noise. **Nov'14**

12. Assume the system in cascade; calculate the noise figure for a circuit connected in cascade. **May'15**

UNIT 5

PART-A

1. Define Sampling Theorem

A bandwidth signal having no spectral components above fm Hz can be determined uniquely by values sampled at uniform intervals of $Ts \leq 1/2Fm$ Seconds. This particular theorem is also known as the uniform sampling theorem

2. Define Nyquist rate

The Nyquist rate of sampling which gives the minimum sampling frequency needed to reconstruct the analog signal from sampled waveforms ie., $fs \geq 2\ fm$

3.What is meant by natural sampling

The sampling in which flat top rectangular pulse of finite width to sample the analog waveform is called as natural sampling because the top of each pulse in the sampled sequence retains the shape of the original signal during the pulse interval

4. What is meant by sampler implementation

The implementation of a sampler is most commonly done in sample and hold circuits. In this operation a switch and storage mechanism is used to form a sequence of sample of the analog input waveform. These samples look like PAM waveform as the amplitude of the sampled pulses can vary continuously

5. What is meant by transition bandwidth

The realizable filters require non zero bandwidth for the transition between the pass band and stop band commonly known as transition bandwidth.

6. Define Quantization

The conversion of the analog form of the signal to discrete form takes place in quantizer. The sampled analog signal is still analog, because though discretised in time, the signal amplitude can take any value as it may wish. The quantizer forces the signal to take some discrete values from the continuous amplitude values.

7.What is meant by uniform quantizer and quantile interval

When the quantization levels are uniformly distributed over the full range, then the quantizer is called as uniform quantizer. The step size between the quantization levels called as quantile interval.

8. Define SNR at the output of quantiser

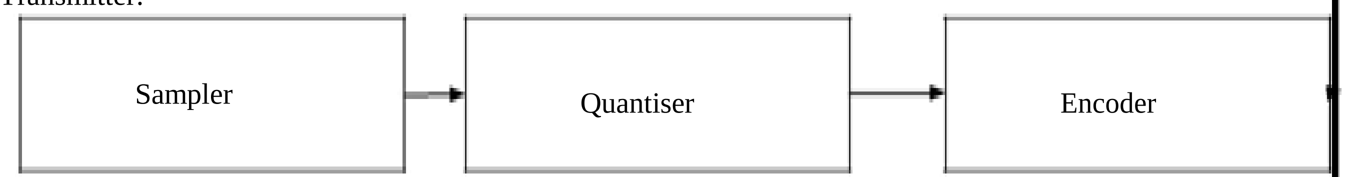
It is defined as the ratio of the signal power to the quantization noise power. Generally noise power is expressed on an average basis whereas the signal power may be peak power or average power

9. Define companding.

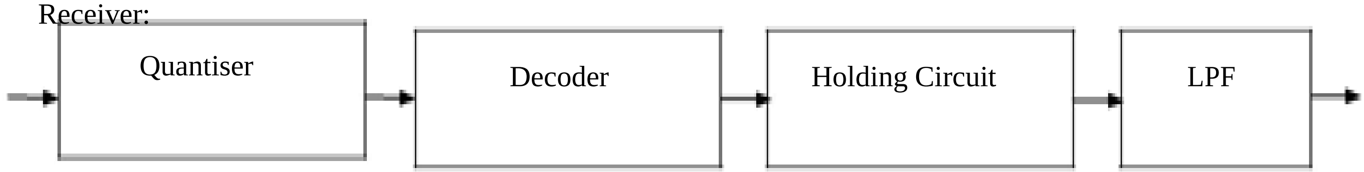
The predistortion of signal by a logarithmic compression characteristics and put it to an uniform quantiser. The compressed and quantized signal is transmitted through the channel and can be undistorted at the receiver by the same algorithm. This process is known as companding. (The process of compression and expansion is collectively referred as companding)

10. Draw the block diagram of PCM systems

Transmitter:



Receiver:



11.What are the noises in typical PCM systems

- Aliasing noise
- Quantization noise
- Channel noise
- Intersymbol noise

12. Define predictor gain

It is defined as the ratio of the variance of the input sequence to the mean square error of the predicted output. It gives an estimate of the factor by which the input signal power dominates the noise power introduced by predictor

13. What are the two types of adaptive quantizers

- Adaptive Quantisation with forward estimation : Unquantised samples of the input singal are used for estimation
- Adaptive Quantization with backward estimation: Samples of quantiser output are used for estimation

14. What is model based encoding

Model based encoding aim to characterize the signal in terms of its various parametes and then encode those parameters not signal. The decoder at the receiver after obtaining the encoded parameter values, synthesisises the signal from those parameters.

15. **In a PCM system the number of bits per symbol is raised from 8 to 10. Then calculate the SNR improvement in dB**.

S/N=4.8+6v

S/N for 8 bits= 4.8+6(8) = 52.8 dB

S/N for 10 bits= 4.8+6(10) = 64.8 dB

16. Compare speech encoding methods

Encoding method	*Quantizer*	*Coder (bits)*	*Transmission rate (kbps)*
PCM	*Linear*	*12*	*96*
PCM	*Logarithmic*	*7-8*	*56-64*
DPCM	*Logarithmic*	*4-6*	*32-48*
ADPCM	*Adaptive*	*3-4*	*24-32*
DM	*Binary*	*1*	*32-64*
ADM	*Adaptive binary*	*1*	*16-32*
LPC			*2.4-4.8*

17. Define 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. This form of signal multiplexing was developed in telecommunications for telegraphy systems in the late 1800s, but found its most common application in digital telephony in the second half of the 20th century.

18.What are the applications of TDM

- The plesiochronous digital hierarchy (PDH) system, also known as the PCM system, for digital transmission of several telephone calls over the same four-wire copper cable (T-carrier or E-carrier) or fiber cable in the circuit switched digital telephone network
- The synchronous digital hierarchy (SDH)/synchronous optical networking (SONET) network transmission standards that have replaced PDH.
- The Basic Rate Interface and Primary Rate Interface for the Integrated Services Digital Network (ISDN).
- The RIFF (WAV) audio standard interleaves left and right stereo signals on a per-sample basis

19. Define SDH Cross connect in TDM

SDH Crossconnect – The SDH Crossconnect is the SDH version of a Time-Space-Time crosspoint switch. It connects any channel on any of its inputs to any channel on any of its outputs. The SDH Crossconnect is used in Transit Exchanges, where all inputs and outputs are connected to other exchanges

20. Why PCM is prepared foe speech?

With the help of sufficient number of bits per sample(8 / 16 bits), it is possible to obtain good dynamic range with PCM. Speech applications have wide dynamic range.

PART-B

1. Define sampling and explain Impulse sampling and Natural sampling in detail
2. Explain sampler implementation without oversampling and with oversampling
3. Explain Quantization and its types
4. Explain PCM system, word size and bandwidth
5. Explain noise in PCM System
6. Derive the SNR for Non-uniform quantization?
7. Draw and Explain Time Division Multiplexing and its application
8. Explain the concept of aliasing and its effect and explain how to overcome aliasing.
9. Explain Logarithmic companding of speech signal
10. Explain Aliasing and its effects and give its significance