ST. ANNE'S

COLLEGE OF ENGINEERING AND TECHNOLOGY

(Approved by AICTE, New Delhi. Affiliated to Anna University, Chennai)
(An ISO 9001: 2015 Certified Institution)
ANGUCHETTYPALAYAM, PANRUTI – 607 106.

QUESTION BANK

PERIOD: JAN 2021 – MAY 2021 **BATCH**: 2019 – 2023

BRANCH: ECE **YEAR/SEM:** II/IV

SUBJECT: EC 8491 – COMMUNICATON THEORY

1. **State the differences between single side band and vestigial side band transmission systems. (MAY/JUN 2014) [D]**

Description	**SSB**	**VSB**
Bandwidth	Fm	fm<BW<2fm
Sidebands	One sideband	One of the sideband is partially suppressed and a vestige of the other sideband is transmitted to compensate for that suppression.
Power saving for sinusoidal	83.3%	75%
Power saving for non sinusoidal	75%	75%
SNR	$(S/N)_O = (S/N)_I$	$(S/N)_O = (S/N)_I$
Application	Long range high frequency communication, especially in audio communication	Television transmission

2. **For an AM system the instantaneous value of carrier and modulating signal are 60 sin $\omega_c t$ and 40 sin $\omega_n t$ respectively. Determine the modulation index. (MAY/JUN 2014) [D]**

Given,

$V_m = 40V$

$V_C = 60V$

$m_a = ?$

$m_a = V_m / V_C$

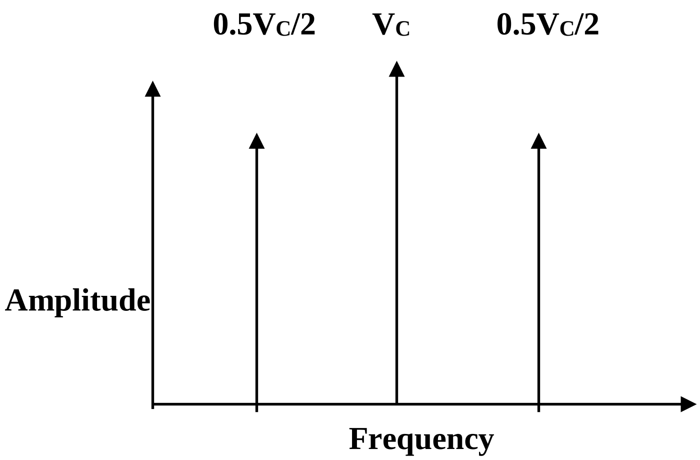
$= 40/ 60$

$m_a = 2/3$

3. **Derive an equation for the modulated signal of an AM system. (MAY/JUNE 2014) [D]**

$$V_{AM}(t) = V_c (1+m_a\cos 2\pi f_m t) \cos (2\pi f_c t)$$

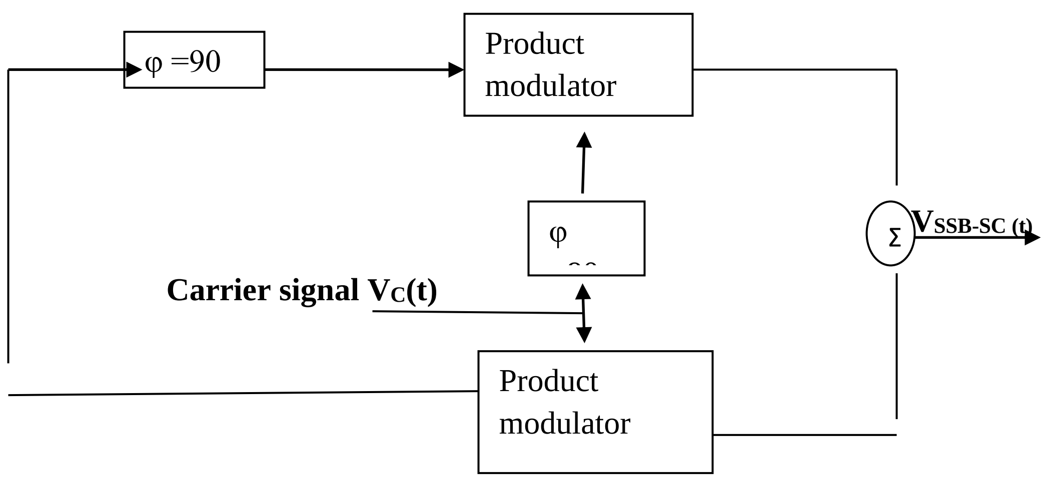
4. **Draw the AM modulated wave for modulation index =0.5 and its spectra. (APR/MAY 2015) [D]**



5. **Define heterodyning. (APR/MAY 2015) [D]**
   The process of mixing two signals having different frequencies to produce a new frequency signal is called as heterodyning.

6. **What is the advantage of conventional DSB-AM over DSB – SC and SSB – SC AM? (NOV/DEC 2015) [D]**
   - DSB-SC is more efficient in use of transmitted power (66.7%) as compared to AM(33.33%).
   - DSB-SC has better signal to noise ratio as compared to single side band transmission.
   - Even though the carrier is suppressed, the bandwidth of DSB-SC remains same as AM and more than SSB.

7. **Draw the block diagram of SSB – AM generator. (NOV/DEC 2015) [D]**



8. **What theorem is used to calculate the average power of a periodic signal $g_p(t)$? State the theorem. (MAY/JUNE 2016) [D]**
   Parseval's theorem

9. **What is pre envelope and complex envelope? (MAY/JUNE 2016) [D]**
   Complex envelope is a frequency shifted version of the analytic signal. Pre envelope or analytic signal is a complex valued signal.

10. Suggest the modulation scheme for the broad cast video transmission and justify. (NOV/DEC 2016) [D]

VSB is used in television for transmission of picture signal. In VSB, the desired sideband is allowed to pass completely. Whereas just a small portion of the undesired sideband is allowed. The transmitted vestige of the undesired sideband compensates for the loss of the desired sideband.

11. What are the advantages of covering low frequency in to high frequency signal? (NOV/DEC 2016) [D]

For efficient radiation, at 5 kHz audio signal requires an antenna of length 30km. the antenna of this height is practically impossible to install.

With help of modulation this low frequency signal can be translated to the higher frequency range and subsequently radiated efficiently from the reduced size antenna.

12. Do the modulation techniques decide the antenna height? (APR/MAY 2017) [ID]

Yes modulation technique decide the antenna height because if the signals are transmitted without modulation, the antenna height is defined as

$\lambda/2 = c/2f = (3*10^8)/(2*5*10^3)$
$= 30,000$ m
$= 30$ km.

13. Determine the bandwidth required for an AM signal obtained by modulating 2 MHz carrier signal by a message signal of 4 KHz bandwidth. (NOV/DEC 2017) [ID]

Given, fm = 2MHz
fc = 4 KHz
BW = 2fm
= 2 x 2MHz
= 4 MHz

14. Why is vestigial modulation preferred in television signal transmission? (NOV/DEC 2017) [ID]

In TV transmission, significant picture details are represented by low frequencies are well preserved by vestigial sideband transmission.

15. Mention the drawbacks of coherent detector? (APR/MAY 2018) [ID]

The detection of DSB-SC and SSB signals are complicated nature because their operation depends upon exact carrier synchronization.

16. Compare and contrast DSB-SC with SSB-SC with respect to i) power ii) bandwidth (APR/MAY 2018) [ID]

Description		**DSB-SC**	**SSB-SC**
Power	For sinusoidal	66.66%	83.3%
	For non sinusoidal	50%	75%
Bandwidth		2fm	Fm

17. How many AM broadcast stations can be accommodated in a 100 kHz bandwidth if the highest frequency modulating a carrier is 5 kHz? [ID]

Bandwidth = 2fm = 2 x 5

= 10 kHz

Number of AM broadcast station = 100/10 = 10

18. Define DSB – SC? [D]

DSB-SC stands for Double sideband suppressed carrier. In this type of modulation the modulated wave consists of only upper and lower sidebands.

The transmitted power is saved here through the suppression of the carrier wave because it does not contain any useful information, but the channel bandwidth required is the same as AM.

19. Write the properties of Hilbert transform? [D]

A signal X(t) and its hilbert transform $X_h(t)$ have the same energy density spectrum.

A signal X(t) and its hilbert transform $X_h(t)$ have the same autocorrelation function.

A signal X(t) and its hilbert transform $X_h(t)$ are mutually orthogonal, that is,

$$\int_{-\infty}^{\infty} X(t).X\,h(t)\,dt = 0$$

20. What are the advantages of VSB-AM? [ID]

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

21. Define super heterodyne principle. [D]

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

22. Compare AM with DSB-SC and SSB-SC. [D]

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

23. What is the difference between high level and low level modulation? [ID]

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

24. Define Coherent Detection. [ID]

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

25. Write the applications of Hilbert transform? [ID]

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

26. **What are the methods for generating SSB-SC signal**? **[ID]**

SSB-SC signals may be generated by two methods as under:
(i)Frequency discrimination method or filter method.
(ii)Phase discrimination method or phase-shift method.

27. What is modulation? What is the need for modulation? [D]

Modulation:

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

Need for modulation:

The modulation process is required in a communication system to achieve the following basic needs:

- Easy of radiation
- Adjustments of bandwidth
- Reduction in antenna height
- Avoids mixing of signals
- Multiplexing
- Increase the range of communication
- Improved quality reception
- Efficient transmission

28. Distinguish between linear and non linear modulator[ID]

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

29. What is modulation index of an AM signal and write its classification.

Modulation index is the ratio of amplitude of modulating signal (Em) to amplitude of carrier (Ec).

- Under modulation ($m < 1$)
- Critical modulation ($m=1$)
- Over modulation ($m>1$)

30. Define heterodyning? [ID]

The process of mixing two signals having different frequencies to produce a new frequency signal is called as heterodyning.

31. *Compare AM with DSB-SC and SSBSC.* (April 2018) [ID]

AM	***DSB-SC***	***SSB-SC***
Bandwidth=2fm	*Bandwidth=2fm*	*Bandwidth=fm*
Contains USB, LSB, carrier	*Contains USB,LSB*	*Contains LSB or USB*
More power is required for Transmission	*Power required is less than that of AM.*	*Power required is less than AM &DSB-SC*

32. *What are the advantages of super heterodyne receiver over TRF?*
What are the characteristics of super heterodyne receiver?* [ID] *(May 2010,2019)

The advantages of super heterodyne receiver over TRF are

- *High selectivity and sensitivity.*
- *Uniform bandwidth because of fixed intermediate frequency.*
- *It eliminates image frequency.*
- *Improved stability.*

33. *A transmitter supplies 8 Kw to the antenna when modulated. Determine the total power radiated when modulated to 30%.* [Apr - 2019] [ID]

Given data:

% modulation m=0.3, carrier power,
Pc=8 kw **Formula:** $Pt=Pc(1+m^2/2)$

$Pt=8.36$ *kw*

34. A carrier of 6kV is amplitude modulated by an audio signal of 3 kV. Find the modulation index. (Nov 2018)[ID]

Vm = 3kV
Vc= 6kV
Modulation index m= Vm/Vc = 3k/6k
m=0.5

35. What are advantages of converting low frequency signal to high frequency signal? (Nov 2018) [ID]

In multiplexing, low frequency signals are converted to high frequency signals and combined with other high frequency signals so that you can pack multiple signals into a single signal, although this combined signal will have a greater bandwidth.

36. What are the advantages of coherent detection? (April 2018) [D]

Coherent detection therefore offers several key advantages compared to direct detection:

1. Greatly improved receiver sensitivity.
2. Can extract amplitude, frequency, and phase information from an optical carrier, and consequently can achieve much higher capacity in the same bandwidth.

37. A message signal has a bandwidth of W. Write the message signal bandwidth for DSB-SC and SSB-SC.(Nov/Dec 2019)

For DSB-SC, BW=2fm, BW=2W
SSB-SC, BW=fm, BW=W

38. Let a signal x(t)= A cos(wct) is passed through a Hilbert transform H(t) . Find the output y (t) of H (T) (Nov/Dec 2019).

Y (t) = (90+x(t))= A sinwct.

PART B
[1st half]

Generation and Detection of AM wave-spectra-DSBSC

1. Explain with suitable diagrams the generation of AM using square law method. Also derive its efficiency. (8M) **(APR/MAY 2015) [D]**
2. Explain the demodulation of AM using envelope detection. (8M) **(APR/MAY 2015) [D](Nov/Dec 2019)**
3. With relevant diagrams, describe the process of demodulation of DSB – SC AM signal. (8M) **(NOV/DEC 2015) [D]**
4. Derive the expression for DSB-SC AM and calculate its power & efficiency. Explain a method to generate and detect it. (13 M) **(MAY/JUNE 2016) [D]**
5. Derive n expression for output voltage of balanced modulator to generate DSB-SC and explain its working principle. (5M) **(APR/MAY 2017) [D]**
6. Discuss the detection process of DSB-SC and SSB-SC using coherent detector. Analyze the drawback of the suggested methodology. (8M) **(APR/MAY 2017)**
7. Describe the function of synchronous demodulator. (8 M**) (NOV/DEC 2017) [D]**
8. Using suitable circuit, explain the operation of envelope detector. Commend the reason for diagonal clipping and suggest the necessary conditions and expressions to overcome the same? (13)**(APR/MAY 2018) [D]**
9. Derive the expression for amplitude modulated wave and explain any one method to generate and demodulate it. (13)**(NOV/DEC 2016) [D]**
10. Derive the expression for DSB-SC AM. Explain a method to generate and detect it. (13)**(NOV/DEC 2016) [D]**

[2nd half]

Hilbert Transform

11. Explain the Hilbert Transform with an example. (8M) **(APR/MAY 2015) [D]**
12. Using the concept of Hilbert transform, generate the SSB-SC wave using phase shift method? (13)**(APR/MAY 2018) [D]**

SSB and VSB –comparison –Super heterodyne Receiver

13. Explain with block diagram the super heterodyne receiver. (8M) **(APR/MAY 2015) [D] [D]**

    Or

    With a neat diagram, explain the function of super heterodyne receiver. (8M) **(NOV/DEC 2015) [D] [D]**

    Or

    Explain about super heterodyne receiver with neat diagram. (13 M) **(MAY/JUNE 2016) [D]**

    Or

    Comment the choice of IF selection and image frequency elimination. (5M) **(APR/MAY 2017) [D]**

    Or

    Elucidate the working principle of super heterodyne receiver with neat block diagram. (8M) **(APR/MAY 2017) [D]**

    Or

    With the neat block diagram, elaborate the working principle of AM super heterodyne receiver. Also highlight how super heterodyne receiver rectifies the drawback of TRF receiver with respect to receiver sensitivity.(14) **(APR/MAY 2018) [D]**
14. Compare AM, SSB and VSB in terms of their bandwidth and power requirements. (8**)(NOV/DEC 2017) [D]**
15. Explain the phase shift method of generation of SSB SC signal with net block diagram. (7) **(NOV/DEC 2017) (Nov/Dec 2019) [D]**
16. Define the need of VSB modulation technique in TV broadcasting. Also sketch the frequency spectra? (7) **[D]**
17. Draw an envelope detector circuit used for demodulation of AM and explain its operation. (7) **(MAY/JUNE2012) [ID]**
18. How SSB can be generator using Weavers method? Illustrate with a neat block diagram.(13) **(MAY/JUNE2012) [ID]**
19. What is frequency division multiplexing? Explain. (8) **(MAY/JUNE2012) [D]**
20. Compare various Amplitude modulation Systems. (14) **(MAY/JUNE2012) [ID]**
21. Define Amplitude modulation .how an amplitude modulated signal can be generated using a non linear modulated circuit. (8) **(Nov/Dec 2012) [D]**
22. What is DSB_SC signal? Write the working of a synchronous detector used to detect the DSB_SC signal with the output amplitude spectrum of each block. (7) **(Nov/Dec2012) [D]**
23. Consider an AM signal which is obtained by modulating message signal m(t) using a carrier signal 5 cos(2∏10^6t) with sensitivity 3V^-1.Let m(t)=sinc(2000t)V.A white noise with PSD of 10^-6 Wz. The received signal is passed through ideal channel select filterbefor demodulator.

    (i)Find the transfer of the channel select filter.(Nov/Dec 2019)

    (ii)Draw the PSD at receiver input

    (iii)Calculate SNR at input and output**.**

UNIT II
ANGLE MODULATION

PART A

1. **If the maximum phase deviation in a phase modulation system when a modulating signal of 10 V is applied is 0.1radian, determine the value of phase deviation constant. (MAY/JUN 2014) [ID]**

   Given,

   fm= 10v

   kp = 0.1 V

   mp = ?

   mp = φm =10(0.1) =1

2. **Why is frequency modulation preferable for voice transmission? (MAY/JUN 2014) [D]**

   Voice signal requires the frequencies upto 10 khz. For such a small range of voice frequencies FM does not have wide bandwidth. Hence FM is preferred.

3. **Define lock in range and dynamic range of a PLL. (APR/MAY 2015) [D]**

   Lock in range:

   The range of frequencies over which the PLL can maintain lock

   Dynamic range:

   The range of frequencies over which the PLL can acquire lock with an input signal.

4. **A carrier is frequency modulated with a sinusoidal signal of 2 kHz resulting in maximum frequency deviation of 5 kHz. Find the bandwidth of the modulated signal. (APR/MAY 2015) [D]**

   Given,

   Modulating frequency = 2 kHz

   Maximum frequency deviation = δ = 5kHz

   Bandwidth BW = $2(\delta + f_{m(max)})$

   = 2 (5 X 10^3+2 X 10^3)

   = 14 kHz

5. **Compare amplitude and angle modulation schemes. (NOV/DEC 2015) [D]**

Amplitude Modulation	**Angle Modulation**
It is the process by which amplitude of the carrier signal is varied in accordance with the instantaneous amplitude value of the modulating signal, but frequency and phase of the carrier remains constant	In angle modulation the timing parameters such as phase or frequency of the carrier signal is modulated according to instantaneous amplitude of modulating signal.
It is Inexpensive and low quality form of modulation	It has improved system fidelity and more efficient use of power.
It is used in commercial broadcasting of both audio and video signals	It used in Radio Broadcasting, sound broadcasting in TV, satellite communication, police wireless.
It also known as DSB-FC, because it contains carrier as well as two side bands.	It has Infinite no of side bands.

6. **Write the Carson's rule. (NOV/DEC 2015) [D]**
An approximate rule for the transmission bandwidth of an FM Signal generated by a single tone modulating signal of frequency f m (max) is defined as

$$\therefore BW=2[\Delta f+ f\, m(max)]$$

7. **Define carrier swing. (APR/MAY 2017) [D]**
Refer Q.no.33

8. **Distinguish the features of amplitude modulation and narrow band frequency modulation (NBFM). (APR/MAY 2017)**
In the case of sinusoidal modulation, the basic difference between an AM signal and a narrowband FM signal is that the algebraic sign of the lower side frequency in the narrow band FM is reversed.

9. **How is narrow band FM signal distinguished from wide band FM? (NOV/DEC 2017)**

Description	**WBFM**	**NBFM**
Modulation index	Greater than 1	Less than 1
Maximum frequency deviation	75 khz	5 khz
Range of modulating frequency	30 hz to 15 khz	30 hz to 3 khz
Bandwidth	Large, about 15 times higher than BW of narrow band FM. BW= $2(\Delta f+f_m)$	Small, approximately same as that of AM. BW=$2f_m$
Noise	Noise is more suppressed	Noise is less suppressed
Sidebands	Spectrum contains infinite number of sidebands and carrier.	Spectrum contains two sidebands and carrier.
Application	Entertainment broadcasting that can be used for his high quality music transmission.	FM mobile communication like police wireless, ambulances etc.

10. **Illustrate the relationship between phase and frequency modulated signal. (NOV/DEC 2017) [D]**

FM	**PM**
It is expressed as $V_{FM}(t) = V_c \cos(\omega_c t + m_f \sin\omega_m t)$	It is expressed as $V_{PM}(t) = V_c \cos(\omega_c t + m_P \sin\omega_m t)$
Frequency deviation is proportional to modulating voltage	Phase deviation is proportional to modulating voltage
Noise immunity is better than AM and PM	Noise immunity is better than AM and worse than FM
SNR is better than that of PM	SNR is inferior than FM
FM is widely used	PM is used in some mobile system.

11. **A carrier signal is frequency modulated by a sinusoidal signal of $5V_{pp}$ 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) [D]**

Given, $Fm_{(max)}$ = 10 KHz

$(Af)_{max}$ = 1 KHz

Deviation ratio = 1/10 KHz

= 0.1

BW = 2fm = 2 X 10 = 20 KHz

BW = 2Δf = 2 X1 = 2 KHz

So given FM is Narrow Band FM.

12. **Define modulation index of Frequency modulation and Phase modulation. (NOV/DEC 2016) [D]**

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

$M_p = K_p V_m$

Where,

K_p- deviation sensitivity

V_m- peak modulating signal amplitude

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

$M_f = \Delta_{f/} f_m$

$= (K_f V_m) / f_m$

13. **What is the need for pre-emphasis? (NOV/DEC 2016) [D]**
The noise has greater effect on higher modulating frequencies and less effect on lower ones. Hence higher modulating frequencies should be artificially boosted, so that effect of noise can be reduced. This is done by pre-emphasis.

14. **Differentiate narrow band FM with AM techniques? (APR/MAY 2018,2019) [D]**

NBFM	**AM**
Frequency of the carrier is varied according to amplitude of the modulating signal	Amplitude of the carrier is varied according to amplitude of the modulating signal
Spectrum contains two sidebands and carrier.	In AM only carriervand two sidebands are present.
It used in FM mobile communications like police wireless, ambulances.	Public communication system, AM broadcast applications.

15. **What is the need of limiter circuit in FM systems? (APR/MAY 2018) [D]**
In an FM system, the message information is transmitted by variations of the instantaneous frequency of a sinusoidal carrier wave, and its amplitude is maintained constant.
Any variation of the carrier amplitude at the receiver input must result from noise or interference.

16. **Compare the transmission bandwidth required for narrowband FM and wideband FM. [D]**

NBFM	**WBFM**
BW = $2f_m$ Hz	BW = $2f_m$ Hz

17. **State the Carson's rule.(Apr 2019) [D]**
An approximate rule for the transmission bandwidth of an FM Signal generated by a single tone modulating signal of frequency f m (max) is defined as

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

18. **Define phase deviation and frequency Deviation. [D]**
The maximum phase deviation of the total angle from the carrier angle is called phase deviation.
The maximum departure of the instantaneous frequency from the carrier frequency is called frequency deviation.

19. **List the advantages of AM and FM. [D]**

AM:

- It has very simple modulators and demodulators
- It is relatively inexpensive
- AM wave can travel a long distance

FM:

- Improved noise immunity
- Low power is required to transmit the signal
- Covers a large area with the same amount of transmitted power
- All the transmitted power is useful.

20. **What is meant by detection? Name the methods for detecting FM signals. [D]**

Detection:

The process of recovering the original modulating signal from a modulated signal at the receiver is termed as detection.

Methods:

1. Slope detectors
   Single tuned discriminator
   Stagger tuned discriminator
2. Phase discriminator
   Foster-seeley discriminator
   Ratio detector

21. **Define direct method and indirect method FM. [ID]**

Direct:

In direct FM, the carrier frequency is directly varied in accordance with the amplitude of the input modulating signal, which is referred as narrowband FM (NBFM).

Indirect:

In indirect FM, The modulating signal is first used to produce a narrow-band FM signal, and frequency multipliers are used next to increase the frequency deviation to the desired frequency level.

22. **What are the applications of phase locked loop? [D]**

Phase locked loops are used for various purposes in AM and FM communication.
(i)Automatic frequency correction in FM transmitter uses PLL to keep carrier frequency constant.
(ii)PLL is used direct FM Transmitter uses PLL to keep carrier frequency constant. (iii) PLL is also used in FM demodulators.

23. **What is the basic difference between an AM signal and a narrowband FM signal? [D]**

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

24. **What are the two methods of producing an FM wave?(Apr 2018) [D]**

Basically there are two methods of producing an FM wave. They are
i) Direct method: In this method the transmitter originates a wave whose frequency varies as function of the modulating source. It is used for the generation of NBFM
ii) Indirect method: In this method the transmitter originates a wave whose phase is a function of the modulation. Normally it is used for the generation of WBFM where WBFM is generated from NBFM

25. **List the properties of the Bessel function. [D]**

The properties of the Bessel function is given by,

(i) $J_n(\beta) = (-1)^n J_{-n}(\beta)$ for all n, both positive and negative.
(ii) For small values of the modulation index β, we have $J_0(\beta) = 1$
$J_1(\beta) = \frac{\beta}{2}$
$J_n(\beta) = 0, \; n \geq 2$
(iii) $\sum_{n=-\infty}^{\infty} J_n^2(\beta) = 1$

26. **Differentiate between phase and frequency modulation.(May 2019) [D]**

FM	**PM**
It is expressed as $V_{FM}(t) = V_c \cos(\omega_c t + m_f \sin\omega_m t)$	It is expressed as $V_{PM}(t) = V_c \cos(\omega_c t + m_P \sin\omega_m t)$
Frequency deviation is proportional to modulating voltage	Phase deviation is proportional to modulating voltage
Noise immunity is better than AM and PM	Noise immunity is better than AM and worse than FM
SNR is better than that of PM	SNR is inferior than FM
FM is widely used	PM is used in some mobile system.

27. Why Armstrong method is superior to reactance modulator? [D]

Reactance modulator is direct FM, whereas Armstrong method is indirect FM. Armstrong method generates FM from PM. Hence crystal oscillators can be used in Armstrong method. Therefore frequency stability is better than reactance modulator.

28. **What is the use of crystal controlled oscillator? [D]**

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

30. **What are the disadvantages of balanced slope detector? [D]**

1. Amplitude limiting cannot be provided

2. Linearity is not sufficient

3. It is difficult to align because of three different frequency to which various tuned circuits to be tuned.
4. The tuned circuit is not purely band limited.

31. **Write the advantages and disadvantages of foster-seely discrimination method? [D]**

Advantages:

a) It is much easier to design

b) Only two tuned circuits are necessary and they are tuned to same frequency

c) Linearity is better

Disadvantages:

It requires Amplitude limiting circuit

32. ***Define modulation index of FM.*** **(May2013 /Nov 2016)**

Define the modulation index of FM wave and specify how you will distinguish narrow band and wide band FM respectively. ***(Nov2013)***

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

β ***<<1 Narrow band FM***
β>>1 wide band FM

33. Define frequency Deviation.

Define carrier swing. ***(May 2017)***

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

$\Delta f = fc\ max - fc\ = fc - fcmin$

Carrier swing$=2\Delta f$

$\Delta f = A_m K_f$

A_m *– amplitude of modulating signal(Volts)*

K_f *– Frequency deviation constant or Frequency sensitivity (Hz/Volts)*

35. ***An angle modulated wave is described by the equation***

$V(t) = 10 \cos (2x10^6 \Pi t + 10 \cos 2000\Pi t)$. Calculate

2. Power of the modulated signal

(ii) Maximum frequency deviation (iii) BW ***May 2016***

Given : $A_c = 10$, $\omega_c = 2 \times 10^6 \Pi$, $\omega_m = 2000\Pi$, $fm=1000\ Hz = 1KHz$

(i) $P = A_c^2/2R = 10^2/2x1 = 50W$

(ii) $\Delta f = ?$

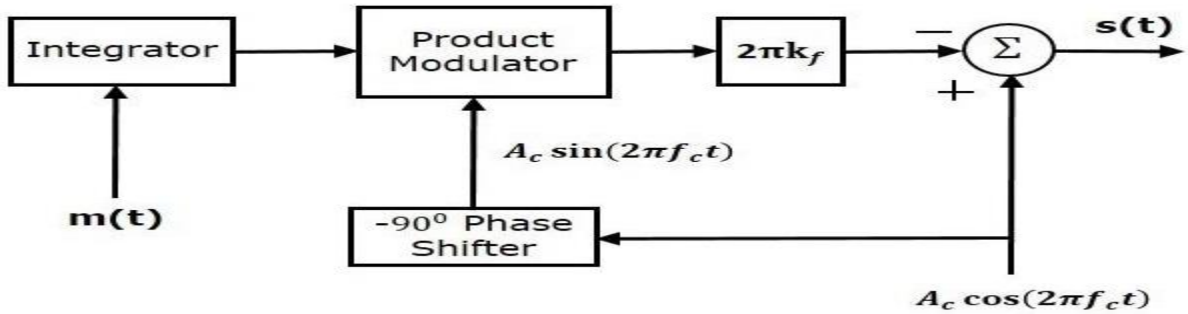
$\beta = \Delta f/f_m \Rightarrow \Delta f = \beta f_m$

$\therefore\ \Delta f = 10x1 = 10\ KHz$

(iii) $B.W = 2(\Delta f + f_m)$

$= 2(10+1) = 22\ KHz$

36. Draw the schematic diagram to generate FM signal from PM.(Nov/Dec 2019)



37.A frequency modulator has freq.deviation 75KHZand BW 15KHz,find message signal BW using carson's rule.(Nov/Dec 2019)

BW=2[Δf+ f m(max)]=2[75K+15k]=180 KHz.

38. Find the power spectral density of a WSS random signal x(t) which has auto correlation r(t).(Nov/Dec 2019)

The *power spectral density* (psd) of a WSS random process $X(t)$ is given by the Fourier transform (FT) of its autocorrelation function

$$S_X(f) = \int_{-\infty}^{\infty} R_X(\tau) e^{-j2\pi f\tau} d\tau$$

PART B

[1st half]

Phase and frequency modulation

1. An angle modulated signal is described by $X_C(t)$ = 10 cos [2π(10^6)t + 0.1 sin (10^3)πt]
   i) Considering Xc(t) as a PM signal with k_p = 10, find m(t). (8 M)
   ii) Considering Xc(t) as a FM signal with k_p = 10π, find m(t). (8 M). **(APR/MAY 2015) [ID]**
2. Explain with diagrams the generation of FM using direct method. (8M) **(APR/MAY 2015) [D]**
3. Obtain the mathematical expression for FM using Bessels function. And also brief the method to determine the bandwidth of FM wave. (14)**(APR/MAY 2018) [D]**

Narrow Band and Wind band FM – Spectrum

4. Obtain the mathematical expression for WBFM. Also compare and contrast its characteristics with NBFM. (6 M) **(APR/MAY 2017) [D]**
5. Obtain the expression for wide band frequency modulated signal and show that it requires infinite bandwidth. Draw the spectrum of FM signal. (13 M) **(NOV/DEC 2017) [D]**

[2nd half]

FM modulation and demodulation

6. Derive the expression for frequency spectrum of FM modulated signal and comment on the transmission bandwidth. (13M) **(NOV/DEC 2015) [D]**

7. Derive n expression for a single tone FM signal with necessary diagrams and draw its frequency spectrum. (10M) **(MAY/JUNE 2016) [D]**
8. Derive an expression for a single tone FM signal with necessary diagrams draw its frequency spectrum. (7) **(NOV/DEC 2016) (Nov/Dec 2019) [D]**
9. Explain the working operation of balanced slope detector. (6) **(NOV/DEC 2016) [D]**
10. Explain the direct method of FM generation?(7) **(NOV/DEC 2016) [D]**
11. Write about the basic principles of FM detection and explain about ratio detector. (7) **(NOV/DEC 2016) [D]**
12. An angle modulated wave is described by v(t) =100 cos(2*10*πt + 10 cos 2000πt). Find i) power of the modulating signal, ii) maximum frequency deviation, iii) band width (6 M) **(MAY/JUNE 2016)**
13. Explain the Armstrong method of FM generation. (8 M) **(MAY/JUNE 2016) [D]**
14. Suggest and discuss the method for the generation of FM using direct method. (7 M) **(APR/MAY 2017) [D]**
15. Discuss the process of FM generation using reactance modulator? (7) **[D]**
16. Highlight the process involved in obtaining amplitude variation from phase variation using FM demodulator circuit? (6) **(APR/MAY 2018) [D]**
17. Elucidate the process of FM demodulation using PLL method? (7) **(APR/MAY 2018) [D]**

FM Discriminator- PLL as FM Demodulator - Transmission bandwidth

18. With the phasor representation explains the foster seeley discriminator. (8M) **(APR/MAY 2015) [D]**
19. With relevant diagrams explain how the frequency discriminator and PLL are used as frequency demodulators? (13M) **(NOV/DEC 2015) [D]**
20. Draw the circuit diagram of a Foster – seeley discriminator and explain its working with relevant phasor diagrams. (8M) **(MAY/JUNE 2016) [D]**
21. With neat diagram explain demodulation of FM signal using balanced frequency discriminator. (13 M) **(NOV/DEC 2017) (Nov/Dec 2019) [D]**
22. Let a Super heterodyne receiver is used to demodulate a FM signal at 100.5 Mhz usinh frequency discriminator and uses IF of 10.7MHz with high side injection of LO.(Nov/Dec 2019)
    - (i) Draw the block diagram of receiver and show how selectivity and fidelity is improved over direct method.
    - (ii) Find LO frequency and image frequency
    - (iii) Comment on image signal whether it is from or out of broadcast FM band and comment on selection of RF filter.

UNIT III

RANDOM PROCESS

PART A

1. Define random variable with an example? (NOV/DEC 2015) [D]

A function which takes on any value from the sample space and its range is some set of real numbers is called a random variable of the experiment. It may be classified as under:

i) Discrete random variable
ii) Continuous random variables

Example:

Sample space and random variables for coin tossing

2. State Bays rule. (NOV/DEC 2015) [D]

If the sample space S is divided into n mutually exclusive events X1,X2,...Xn and Y is an another event, which can occur only if one of the X1,X2,….Xn occurs, then as per Baye's theorem

P(Xi/Y) = P(Y/Xi).P(Xi)/ P(Y/X1)P(X1)+P(Y/X2)P(X2)….P(Y/Xn)P(Xn)

Where , i= 1,2,…n

3. **Define autocorrelation function. (MAY/JUNE 2016) [D]**

The autocorrelation function of the process X(t) is the expectation of the prouct of two random variables $X(t_1)$ and $X(t_2)$ obtained by observing the process X(t) at times t_1 and t_2.

$R_x(t_1,t_2) = E[X(t_1)X(t_2)]$

$= \iint_{-\infty}^{\infty} X1X2f\mathrm{X}(t1)(t2)(X1,X2)dX1\ dX2$

Where, , $f\mathrm{X}(t1)(t2)(X1,X2)$ – **second order probability density function of the process.**

4. **State central limit theorem. (MAY/JUNE 2016) (NOV/DEC 2016) [D]**

It states that the probability density of a sum of N independent random variables tends to approach a normal density as the number N increases. The mean and variance of this normal density are the sum of mean and variance of N independent random variables.

5. State Wiener Khintchine theorem. (APR/MAY 2017) [D]

Or

State Wiener Khintchine relations. (NOV/DEC 2016) [D]

Einstein – wiener khintchine relation give the relationship between power spectral density and autocorrelation function of a stationary random process.

i) Power spectral density: $S_x(f) = \int_{-\infty}^{\infty} RX(\tau)\ \ exp(-j2\pi f\tau)d\tau$
ii) Autocorrelation function: $R_X(\tau) = \int_{-\infty}^{\infty} SX(f)\ \ exp(j2\pi f\tau)df$

6. List the necessary and sufficient condition for the process to be WSS. (APR/MAY 2017) [D](Nov/Dec 2019)

The process may not be stationary in strict sense; still the mean and autocorrelation functions are independent of shift of time origin. Such process is called wide sense stationary process.

7. **Give the mathematical definition of random process? (APR/MAY 2018) [D]**

A random process is an ensemble or sample space. Such sample space consists of sample points whose outcome is random function of time.

Let us assume that the random process is observed over an interval $-T \leq t \leq T$, and then the random process is mathematically represented as X (t,s) $-T \leq t \leq T$

Where, s- sample point in the sample space.

$S_1=x_1(t)$, $s_2 = x_2(t)$…….$s_n = x_n(t)$ and $t = t_k$

$\{X(t_k,s_1);X(t_k,s_2),\ldots..X(t_k,s_n)\} = \{x_1(t),x_2(t)\ldots x_n(t_k)\}$

8. List out the properties of correlation function? [D]

- Mean square value
- Even symmetry
- Maximum value
- Conjugate symmetry
- Energy spectral density

9. Write the difference between random variable and random process. [D]

Sl.no	**Random variable**	**Random process**
1	It is a set of numbers	It is waveform
2	It need not be function of time	It is the function of time
3	RV are not further classified	RP can be classified into Stationary or ergodic
4	Only ensemble averages can be calculated	Ensemble as well as time averages can be calculated

10. Define random process? [D]

It is a process which can be in a number of different states and the transition from one state to another is random.

11. Define stationary process. [D]

When the statistical properties of a process do not change with time it is called stationary process.

12. Define random variable .Specify the sample space and the random variable for a coin tossing experiment. [D]

A function which takes on any value from the sample space and its range is some set of real numbers is called a random variable of the experiment.

Example:

Sample space and random variables for coin tossing

S={H,T}

13. When Random process is called as deterministic? [D]

When the future values of any sample function can be predicted from knowledge of past values then the random process is called deterministic random process.

14. What is the classification of random process? give one example for each[D]

- Stationary process
- Ergodic process

15. State central limit theorem. [D]

When infinitely large number of identically distributed random variables is added, the resultant is Gaussian distributed.

16. Write the Rayleigh and Rician probability density functions. [D]

Rayleigh:

$f_R(r) = (r/\sigma^2)\, e^{-r2/2\sigma2}$

Rician:

$f_R(r) = (r/\sigma^2)\, e^{-(r2+AC2)/2\sigma2} I0(rAc/\sigma^2)$

where σ^2 is a variance of the signal

17. What is covariance for a random process X(t)? [D]

$C_X(t_1,t_2) = E[(X(t_1)-M_x)\,(X(t_2)-M_x)]$

$\quad = R_X(t_2-t_1) - M_x^2$

18. Define mean of a random process. [D]

A random process is an ensemble or sample space. Such a sample space consists of sample points whose outcome is random function of time.

19. List the conditions to be satisfied for wide sense stationary. [D]

The process may not be stationary in strict sense; still the mean and autocorrelation functions are independent of shift of time origin. Such process is called wide sense stationary process.

20. What are the properties of an autocorrelation function? [D]

- Mean square value
- Even symmetry
- Maximum value
- Conjugate symmetry
- Energy spectral density

21. Define Ergodic processes. [D]

A random process is called ergodic process if time averages are equal to ensemble averages. Thus for ergodic process,

$$M_x\,(t) = M_x(T)$$

$$R_X(t_1t_2) = R_x(T)$$

22. What is cross correlation of random processes of X (t) and Y (t)? [D]

Let there be two random processes X (t) and Y (t). Let their autocorrelation functions be $R_X(t,u)$ and $R_X(t,u)$. And their cross correlation functions be defined as:

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

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

It can be expressed in matrix form as follows:

$R(t,u) = [R_X(t,u)\ R_{XY}\ (t,u)$

$\quad R_{YX}(t,u)\ R_Y(t,u)]$

23. Define autocorrelation. [D]

The autocorrelation function is defined as the expection of the product of two random variables which are obtained by observing the random process at different times.

Let the random process be observed at t1 and t2. The corresponding random variables are $X(t_1)$ and $X(t_2)$. Then autocorrelation function will be,

$R_X(t_1,t_2) = E[X(t_1)X(t_2)]$

24. Define Gaussian processes. [D]

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

25. What are the advantages of Gaussian process? [D]

- Modeling as a Gaussian process makes analysis easier.
- It is most suitable for random processes which are generated from physical phenomena.

- Experiments have confirmed the stability of Gaussian model for random processes that are produced by physical phenomena. **[D]**

26. List the properties of Gaussian processes.

- If input is Gaussian, output is also Gaussian.
- Set of random variables obtained by sampling Gaussian process is jointly Gaussian.
- Stationary Gaussian process is strictly stationary process.
- Uncorrelated sample of Gaussian process are statistically independent.

27. Define CDF? [D]

The Cumulative Distribution Function (CDF) of a random variable 'X' is the probability that a random variable 'X' takes a value less than or equal to x.

Where x is the dummy variable.

CDF: $F_X(x) = P(X \leq x)$

28. Define Discrete RV? [D]

The random variable X is a discrete random variable if X can take on only finite number of values in any finite observation interval. Thus the discrete random variable has countable number of distinct values.

For example: X {1,4,9,16,25,36}

29. Define Continuous RV? [D]

If the random variable 'X' takes on any value in a whole observation interval, X is called a continuous random variable.

For example: the noise voltage generated by an electronic amplifier has continuous amplitude.

30. When a random process is called stationary? [ID]

When the statistical properties of a random process do not change with time, it is called stationary random process.

31. ***Define random variable.*** **[D]** (***May 2012 /Dec 2012/Dec 2015)***

Random variable is defined as a function which maps the outcome of a random experiment to a number. It is also known as stochastic variable

Random variables are denoted by upper case letter X,Y etc., Values assumed by RV are denoted by lower case letters with subscripts. x1, x2, y1, y2, etc.,]

32. When is a random process called deterministic? [ID] [Nov 2018]*May 2010 /Dec 2011*

A Random process is called deterministic, if the future values of any sample function can be predicted from past values.

33. ***What is meant by Strict sense stationary process (SSS Process)?*** **[Apr - 2019]**

A Random Process is said to be SSS Process, if its statistical properties are independent of time.

$$E[x(t)] = E[x(t + \tau)]$$

35. **Define Heterodying. [Nov 2018] [D]**

Heterodying is a signal processing technique. It is used to shift one frequency range into another and is also involved in the processess of modulation and demodulation.

36. What is narrow band noise? [April 2018] [D]

Narrow-band noise (NBN) is a type of noise stimulus that is centered around a small range of frequencies. It is produced by filtering a 1/3 octave range from a broad-band noise stimulus.

PART B

[1st Half]

Random variables, Central limit Theorem,

1. Let X and Y are real random variables with finite second moments. Prove the Cauchy Schwarz inequality. $(E[XY])^2 \leq E[X^2]\, E[Y^2]$. (8 M) **(APR/MAY 2015) [D]**
2. In a binary communication system, let the probability of sending a 0 and 1 be 0.3 and 0.7 respectively. Let us assume that 0 being transmitted, the probability of it being received as 1 is 0.01 and the probability of error for a transmission of 1 is 0.1. i) What is the probability that the output of this channel is 1? ii) If a1 is received, then what is the probability that the input to the channel was 1? (13 M) **(NOV/DEC 2015) [ID]**
3. Let $X(\tau)= A \cos(\omega t + \varphi)$ and $Y(t)= A \sin(\omega t + \varphi)$ where A and ω are constants and φ is uniform random variable in (0, 2π). Find the cross correlation function x(t) and y(t). (8 M) **(APR/MAY 2015) (Nov/Dec 2019) [ID]**
4. Give a random process, $X(t) = A \cos(\omega t + \mu)$ where A and ω are constants and μ is a uniform random variable. Show that X (t) is ergodic in both mean and autocorrelation. (8 M) **(MAY/JUNE 2016) [ID]**
5. Let X and Y be defined as $X= 2\cos\theta$ and $Y=3 \sin\theta$, where θ is a random variable uniformly distributed over [0,2π]. Determine the mean, autocorrelation function of X and cross correlation of X and Y. (8 M) **(NOV/DEC 2017) [ID]**

Random Process, Stationary Processes,

6. List the different types of random process and give the definition.(7) **(MAY/JUNE2012) [D]**
7. Differentiate the strict sense stationary with that of wide sense stationary process. (8M) **(APR/MAY 2015) [D]**
8. 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. (8 M) **(APR/MAY 2015) [D]**
9. When is random process is said to be a strict sense stationary (SSS), wide sense stationary (WSS) and ergodic process. (8M) **(MAY/JUNE 2016) (NOV/DEC 2016) [D]**
10. State the differences between: i) random variable and random process (4 M) **[D]**
    iii) Strict sense stationary process and wide sense stationary process. (4 M) **(NOV/DEC 2017)**
11. The amplitude modulated signal is defined as $X_{AM}(t) = Am(t) \cos(\omega_c t + \theta)$ where m(t) is the baseband signal m(t) is modeled as a zero mean stationary random process with the autocorrelation function $R_{xx}(\tau)$ and the PSD $G_x(f)$.the Carrier amplitude A and the frequency ω_c are assumed to be constant and the initial carrier phase θ is assumed to be a 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 $X_{AM}(t)$. (13 M) **(APR/MAY 2017) (Nov/Dec 2019) [ID]**

[2nd Half]

Mean, Correlation & Covariance functions, Power Spectral Density, Ergodic Processes, Gaussian Process,

12. Define the following terms mean, correlation, covariance and ergodicity.(7) **(NOV/DEC 2016) [D]**

13. What is Gaussian random process and mention its applications. (7) (NOV/DEC 2016) **[D]**
14. What is CDF and PDF? State their properties. Also discuss them in detail by giving examples of CDF and PDF for different types of random variables. (13 M) **(NOV/DEC 2015) [D]**
15. 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. (8 M) **(MAY/JUNE 2016) [ID]**
16. State and justify the properties of auto correlation function. (8 M) **(NOV/DEC 2017) [D]**

Or

Discuss the properties of Auto correlation function. (8 M) **(APR/MAY 2018) [D]**

17. State and explain the properties of Gaussian Process. (8 M) **(APR/MAY 2018) [D]**
18. Consider the quadrature amplitude modulated signal: Y(t) = X(t) cos(ωt)–Z(t) sin(ωt), X(t) and Z(t) are zero mean independent processes with identical autocorrelations , $R_X = R_Z$. Determine $R_Y(t_1,t_2)$, and show that if $R_X(t_1,t_2) = R_X(t_1-t_2)$ and $R_Y(t_1,t_2) = R_Y(t_1-t_2)$. (8 M) **(APR/MAY 2018) [D]**

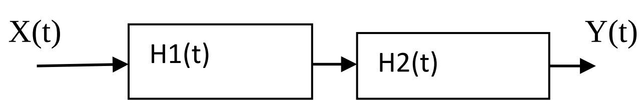
Transmission of a Random Process through a LTI filter.

19. Explain in detail about the transmission of a random process through a linear time in variant filter. (8 M) **(MAY/JUNE 2016) (NOV/DEC 2016) [D]**

Or

With suitable sketches, expressions explain the transmission of random process through LTI filter. (8 M) **(APR/MAY 2018) [D]**

20. Consider two linear filters connected in cascade as shown in fig 1. Let X(t) be a stationary process with a auto correlation function $R_x(\tau)$, the random process appearing at the first input filter is V(t) and the second filter output is Y(t). i) Find the autocorrelation function of Y (t). ii) Find the cross correlation function $R_{vy}(\tau)$ of V(t) and Y(t). **[ID]**



(13 M) **(APR/MAY 2017)**

UNIT IV
PART A
NOISE CHARACTERIZATION

1. **State the need for pre-emphasis and de-emphasis circuits in the field of communication. (MAY/JUNE 2014) (MAY/JUNE 2016) [D]**

   Pre-emphasis circuit which boosts the signal amplitude of higher frequency component in the message band at the transmitter before modulation. The boosted signal at transmitter increases, the (S/N)o ratio at the detector output. (S/N)o ratio becomes large enough to improve the threshold level over the entire message band.

   The artificial boosting given to the higher modulating frequencies in the process of pre-emphasis is nullified or compensated at the receiver by a process called de-emphasis. The artificially boosted high frequency signals are brought to their original amplitude using the de-emphasis circuit.

2. **Define white noise**. **(MAY/JUNE 2014) [D]**

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

3. **Define noise figure. (MAY/JUNE 2014) (NOV/DEC 2015)(May 2019) [D]**

   Noise figure is defined as "the ratio of the signal to noise power ratio at the input terminals of a receiver (or) amplifier to the signal to noise power ratio at the output terminal (or) load resistor".

4. **What is preemphasis? Why it is needed? (APR/MAY 2015) [D]**

   Pre-emphasis circuit which boosts the signal amplitude of higher frequency component in the message band at the transmitter before modulation.

   The boosted signal at transmitter increases, the (S/N)o ratio at the detector output. (S/N)o ratio becomes large enough to improve the threshold level over the entire message band.

5. **Define threshold effect in FM system? (APR/MAY 2015) (NOV/DEC 2015) (NOV/DEC 2017)**

   When the carrier to noise ratio is slightly less than unity, the frequency of spike generation is small, and each spike produces individual "clicking sound" in the receiver. But when the carrier to noise ratio is further decreased so that the ratio is moderately less than unity, the spikes are generated rapidly, and the licks merge into a sputtering sound. This phenomenon is known as threshold effect in FM.

6. **Give the definition of noise equivalent temperature? (MAY/JUNE 2016) [D]**

   It is defined "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 output of the system as that produced by all the sources of noise in the actual system".

7. **Define capture effect in FM system? (MAY/JUNE 2016) [D]**

   When FM signals from two transmitters operated on the same or nearly same carrier frequency reach the receiver simulataneously, the signal of a weak magnitude is suppressed by a strong signal, and the FM receiver reproduces only the strong signal. These called capture effect in FM system.

8. **What is meant by image frequency? How to overcome it? (NOV/DEC 2017) [D]**

The unwanted signal at frequency fsi is known as the “image frequency” and it is said to be the “image” of the signal frequency fs. The image frequency must be rejected by the receiver. It is gn by

$F_{si} = f_o + f_i$

Where, fs – signal frequency

Fi – intermediate frequency

It must be rejected by the receiver. The image rejection is depends on the front end selectivity of the receiver.

9. **List the properties of white noise? (NOV/DEC 2017) [D]**
   - The power spectrum of white noise is constant and independent of frequency.
   - Probability of occurrence of white noise specified by a Gaussian distribution function
   - The autocorrelation function of white noise consists of Delta Function $\delta(\tau)$ weighted by a factor No/2.

10. **Determine the thermal noise voltage induced by a 50 ohm resister when operating at 5 kHz bandwidth under room temperature. (NOV/DEC 2017). [D]**

Given, R= 50 ohm

B= 5 KHz

T = room temperature.

V_N= ?

$V_N = \sqrt{4KTRB}$

11. **Specify the cause of threshold effect in AM receiver. (APR/MAY 2017) [D](Nov/Dec 2019)**

In AM receiver, when the carrier to noise ratio reduces below certain value, the message information is lost. The performance of AM receiver deteriorates rapidly and it has no proportion o carrier to noise ratio. This is called threshold effect in AM system.

12. **Comment the role of pre-emphasis and de-emphasis circuit in SNR improvement. (APR/MAY 2017) [ID]**

Pre-emphasis:

The pre- emphasis circuit which boosts the signal amplitude of higher frequency component in the message band at the transmitter before modulation.

The boosted signal at transmitter increases, the (S/N)o ratio at the detector output. (S/N)o ratio becomes large enough to improve the threshold level over the entire message band.

De-emphasis:

The artificial boosting given to the higher modulating frequencies in the process of pre-emphasis is nullified or compensated at the receiver by a process called de-emphasis.

The artificially boosted high frequency signals are brought to their original amplitude using the de-emphasis circuit.

13. **Define noise figure and noise equivalent temperature? (NOV/DEC 2016)(Apr 2019) [D]**

Noise figure is defined as “the ratio of the signal to noise power ratio at the input terminals of a receiver (or) amplifier to the signal to noise power ratio at the output terminal (or) load resistor”

It is defined “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 output of the system as that produced by all the sources of noise in the actual system".

14. Two resistors of 20K, 50K is at room temperature (290K). For a bandwidth of 100 kHz. Calculate the thermal noise voltage generated by two resistors in series. (NOV/DEC 2016) [ID]

Given, R1= 20K, R2 = 50K, R= 70 K

T=290K

B= 100 KHz

V_N = ?

Thermal noise voltage $V_N = \sqrt{4KTRB}$

= 1V

15. Define narrow band noise. [D]
(Or)
What is narrow band noise? (APR/MAY 2018) [D]

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

16. Define the reason why SNR of the receiver should be high? (APR/MAY 2018) [D]

The noise performance and signal to noise ratio is a key parameter for any radio receiver. The SNR is often used to measure the sensitivity performance of a receiver. So the SNR of the receiver should be high in any communication system.

17. How does preemphasis and de-emphasis process provide overall SNR improvement is FM systems? (APR/MAY 2018) [D]

Pre-emphasis:

The pre- emphasis circuit which boosts the signal amplitude of higher frequency component in the message band at the transmitter before modulation.

The boosted signal at transmitter increases, the (S/N)o ratio at the detector output. (S/N)o ratio becomes large enough to improve the threshold level over the entire message band.

De-emphasis:

The artificial boosting given to the higher modulating frequencies in the process of pre-emphasis is nullified or compensated at the receiver by a process called de-emphasis.

The artificially boosted high frequency signals are brought to their original amplitude using the de-emphasis circuit.

18. What are the methods to improve FM threshold reduction? [D]

The following two methods used for improvement of the FM threshold reduction:

1. Pre-emphasis and de-emphasis
2. FMFB (FM demodulator with negative feedback)

19. What is white noise? Give its Characteristics. [D]

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

Characteristics:

- The power spectrum of white noise is constant and independent of frequency.
- Probability of occurrence of white noise specified by a Gaussian distribution function
- The autocorrelation function of white noise consists of Delta Function $\delta(\tau)$ weighted by a factor No/2.

20. Mention the properties of narrowband noise? [D]

The in-phase and quadrature components of a narrowband noise have important properties:

- n_I (t) & n_Q(t) of narrowband noise have zero mean.
- If n_I (t) is gaussian, then its n_I (t) and n_Q(t)are jointly Gaussian.
- If n_I (t) is stationary, then its n_I (t) and n_Q(t) are jointly Stationary.
- n_I (t) and n_Q(t) have same variance as n(t).

21. Define noise equivalent bandwidth[D]

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

22. Give the characteristic of shot noise[D]

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

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

23. What is shot noise? [D]

When current flows in electronic device, the fluctuations number of electrons or holes generates the noise.

It is called shot noise. Shot noise also depends upon operating conditions of the device.

24. Define noise and Give the classification of noise. [D]

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

Noise is broadly classified into two types. They are

(i)External noise

(ii)Internal noise.

25. What are the types of extraterrestrial noise and write their origin? [ID]

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

26. Define flicker noise. [D]

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

27. **State the reasons for higher noise in mixers**. **[D]**

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.

28. Define signal to noise ratio. [D]

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

29. Define thermal noise. Give the expression for the thermal noise voltage across a resistor. [D]

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

30. What is narrowband noise? [D]

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

31. *If two resistors 20KΩ & 50KΩ are connected at temperature 70℃ for a BW of 100KHz. Calculate the (i) noise voltage of each resistor and (ii)when two resistors are in series (iii) resistors in parallel*. [ID]

Given: **[Apr - 2019]**

R1 = 20 KΩ. R2 = 50 KΩ.

T = 70℃ ⇒ 70 + 273 = 343K

BW=100KHz

Solution:

(i) Noise voltage of each resistor

For R1 = 20 KΩ.

VTN=√

$$V_{TN} = \sqrt{4 \times 1.38 \times 10^{-23} \times 343 \times 20 \times 10^{3} \times 100 \times 10^{3}}$$

$$= 6.15\mu V$$

For R2 = 50 KΩ.

$$V_{TN} = \sqrt{4 \times 1.38 \times 10^{-23} \times 343 \times 50 \times 10^{3} \times 100 \times 10^{3}}$$

$$= 9.729\mu V$$

(ii) When resistors are in series

$$V_{TN} = \sqrt{4KTB(R1 + R2)}$$

$$V_{TN} = \sqrt{4 \times 1.38 \times 10^{-23} \times 343 \times 100 \times 10^{3} \times (50 + 20) \times 10^{3}}$$

$$= 11.51\mu V$$

(iii) When resistors are in parallel

$V_{TN} = \sqrt{4 \times 1.38 \times 10^{-23} \times 343 \times 100 \times 10^{3}\, Req}$

$1/Req = 1/R1 + 1/R2 \Rightarrow Req = R1R2 = \frac{50 \times 20 \times 10^{6}}{}$

Req = 14.28KΩ

$V_{TN} = \sqrt{4 \times 1.38 \times 10^{-23} \times 343 \times 100 \times 10^{3} \times 14.28 \times 10^{3}}$

$\boldsymbol{V_{TN} = 5.200 \mu V}$

32. A noisy system has noise factor of 2.Find its noise figure and noise equivalent temperature.(Nov/Dec 2019)

Noise Figure (NF) = 10 * log (noise factor) dB=10log(2)=3.321 dB

Noise temperature (T) = 300 * (10^(Noise Figure/10)-1) K=300*(10^(3.321/10-1) =645 K

PART B

[1st half]

Noise sources and types

1. Define noise. Explain the various types of internal noise. (8 M) **(APR/MAY 2015) [D]**
2. Classify the different noise sources and its effect in real time scenario. (7 M) **(APR/MAY 2017)**

   Or

   Classify the different types of noise and also comment its causes and effects? (7) **(APR/MAY 2018)**
3. Define noise and write shot notes on shot, thermal and white noise. (8) **(NOV/DEC 2016) [D]**

Noise figure and noise temperature – Noise in cascaded systems. Narrow band noise – PSD of in-phase and quadrature noise

4. Explain with derivation the effect of noise in cascaded amplifier circuit. (8 M) **(APR/MAY 2015) [D]**
5. Define narrow band noise and explain the representation of narrow band noise in terms of In-phase and Quadrature components. (8 M) **(MAY/JUNE 2016) [D]**
6. Discuss the effects of noise in cascaded system. (6 M) **(APR/MAY 2017) [D]**
7. Prove that the random band pass noise signal n(t) can be expressed as $n(t)= n_e(t)$ (cos $\omega_c(t)$ + $n_s(t)\sin\omega_c(t)$ $n_e(t)$and $n_s(t)$ are low frequency band limited to ω_m radians/seconds. (8**) (APR/MAY 2018) [ID]**
8. Derive the relationship between noise fig and equivalent noise temperature. (6) **(MAY/JUNE2013)**
9. A mixer stage has a noise fig of 20 db and this is preceded by an amplifier that has a noise fig of 9db and an amplifier gain of 15db.calculate the overall noise figure referred to the input.(13) **(NOV/DEC2012) [ID]**
10. A receiver has a noise fig of12db and it is fade by allow noise amplifier that has again of 50db and a temperature of 90k.Calculate the noise temp.of the receiver and the overall noise temperature of the receiving system take room temp is 290K. (13)**(NOV/DEC2012) [ID]**

[2nd half]

Noise performance in AM systems

11. Derive the SNR performance of DSB system and the AM system. Also prove that the output SNR in AM is at least 3dBworse than that of DSB system. (13 M) **(APR/MAY 2015) [D]**
12. Explain the noise in DSB-SC receiver using synchronous or coherent detection and calculate the figure of merit for a DSB-SC system? (13 M) **(MAY/JUNE 2016) [D]**
13. Derive the figure of merit of AM system. Assume coherent detector. (7) **(NOV/DEC 2016) [D]**
14. Derive an expression for signal to noise ratio for an AM signal, with assumption that the noise added in the channel is AWGN. Compare its performance with FM system. (13 M) **(APR/MAY 2017) [ID]**

Noise performance in FM systems- Pre-emphasis and de-emphasis – Capture effect, threshold effect

15. What is capture effect in FM. (6) **(MAY/JUNE2012) [D]**
16. Explain FM threshold. (6) **(MAY/JUNE2013) [D]**
17. 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 No = 10 – 14 W/Hz? The power of the normalized message signal is assumed to be 0.1watt and the required SNR after demodulation is 60 dB.(13 M) **(NOV/DEC 2015) [ID]**
18. Explain pre-emphasis and de-emphasis in FM. (8 M) **(MAY/JUNE 2016) (Nov/Dec 2019) [D]**
19. Derive the figure of merit expression for FM receiver and explain the need for pre-emphasis and de-emphasis in FM system. (13 M) **(NOV/DEC 2017) [ID]**
20. Explain the noise in FM receiver and calculate the figure of merit for a FM system. (13)**(NOV/DEC 2016) [D]**

    Or

    Obtain the expression for the figure of merit for an FM signal, with assumption that the noise added in the channel is additive White Gaussian Noise. (13) **(APR/MAY 2018) (Nov/Dec 2019) [D]**

UNIT V

SAMPLING & QUANTIZATION

PART A

1. **Define Bit rate and Band rate of digital modulation. [D]**
   Bit rate is measure of the number of data bits transmitted in one second.
   Baud rate means the number of times a signal in a communications channel changes state.

2. **Define pulse modulation. List the four most common methods of pulse modulation. [D]**
   In pulse modulation, some parameter of a carrier pulse train is varied in accordance with the message signal.
   1. Pulse code modulation
   2. Pulse amplitude modulation
   3. Pulse duration modulation
   4. Pulse position modulation

3. **Discuss about alaising. [D]**
   If the sampling frequency "f_s" is less than the Nyquist rate, then a distortion called "aliasing" is introduced in the spectrum of the sampled signal.
   $f_s > 2f_m$
   when the high frequency component in the spectrum of the signal inrerferes with low frequency and appears as low frequency then the phenomenon is called aliasing.

4. **State sampling theorem.(MAY 2019) [D]**
   A continuous time signal can be completely represented in its sample and received back. If the sampling frequency is twice of the highest frequency content of the signal. It can represents as :
   $f_s \geq 2f_m$

   Where, f_s- sampling frequency

   f_m – maximum frequency of the continuous signal

5. **Write the types of sampling method? [D]**
   There are three sampling methods that can be employed.
   - Ideal or instantaneous sampling
   - Natural sampling
   - Flat topped sampling

6. **Define aperture effect. [D]**
   During flat top sampling, to convert varying amplitudes of pulses to flat top pulses we use a sinc function. Because of this, there would be decrease in amplitude. This is named as aperture effect.
7. **Define PCM.What are the elements are in PCM system? [D]**
   PCM is essentially an analog to digital conversion process, where the information contained in the instantaneous sample of analog signal are represented by digital codes and are transmitted as a serial bit stream.
   A pulse code modulation system includes the following basic element.
   - Transmitter
   - Transmission path

- Receiver

8. **Define quantization and quantization error? [D]**
The process of making the signal discrete in amplitude by approximating the sampled signal to the nearest predefined or representation level is called quantization.
The difference between the instantaneous values of the quantized signal and input signal is called as quantization error or quantization noise.
$\varepsilon = xq(t) - x(t)$
9. **Give various types of quantization and explain it? [D]**
They are two types of quantization
   1. Uniform quantization
   2. Non uniform quantization

   In quantization, hen step size between any two adjacent levels is same throughout the signal range is called uniform quantization.

   In the step size varies depending on the input signal values then the quantizer is known as the non-uniform quantizer.

10. **Why non – uniform quantization is preferred for most of the practical purposes? [D]**
Generally non-uniform quantization is preferred for most of the practical purposes because it provides the production for low level signals which are more precious than large amplitude samples.
11. **What is PAM, PPM, PWM, PTM? [D]**
PAM stands for Pulse Amplitude Modulation. The amplitude of pulse carrier is changed in proportion with the instantaneous amplitude of the modulating signal.
PPM stands for pulse Position Modulation. The amplitude and width of the pulses are kept constant but the position of the each pulse is varied in accordance with the amplitude of the sampled values of the modulating signal.
PWM stands for Pulse Width Modulation. The width of the modulated pulses in proportion with the amplitude of modulating signal.
PTM stands for Pulse Time Modulation. In this amplitude of pulse is held constant, whereas position of pulse or wide of pulse is made proportional to the amplitude of signal at the sampling instant.

12. **List out the different PCM sampling techniques [D]**
There are two basic techniques to perform sampling function.
    - Natural sampling
    - Flat sampling

13. **What are the basic operations performed in PCM transmitter? [D]**
    - Sampling
    - Quantizing
    - Encoding
14. **Define PCM transmission path [D]**
It is referred as “the path between PCM transmitter and PCM receiver over which the PCM signal travel”.
15. **Define quantization levels? [D]**

    Each sampled value at the quantizer is approximated or rounded off to the nearest standard predicted voltage level. These standard levels are known as “quantization levels”.

16. **What is Companding? [D]**
It is the process of compressing and then expanding. Analog signals are compressed prior to transmission and then expanded in the receiver.

17. **Define analog Companding? [D]**
Analog compression was implemented using specially designed diodes inserted in the analog signal path in a PCM transmitter prior to the sample and hold circuit.
Analog expansion was also implemented with diodes that were placed just after the low pass filter in PCM receiver.

18. **List out the different methods of analog Companding? [D]**
The two methods are:
1) μ – law
2) A – law Companding.

19. **List out difference between μ law and A law Companding? [D]**
It has a slightly flatter SQR than μ law. It is interior to μ law in terms of small signal quality.

20. **Define Digital Companding?**
It involves compression in the transmitter after the input sample has been converted to a linear PCM code and then expansion in the receiver prior to PCM decoding.

21. **Define multiplexing? [D]**
Different users signals can be transmitted in a single channel simultaneously using a technique called multiplexing.

22. **Define TDM? [D]**
TDM stands for Time Division Multiplexing is a method of putting multiple data streams in a single signal by separating the signal into many segments, each having a very short duration. Each individual data stream is reassembled at the receiving end based on the timing.

23. **Define FDM? [D]**
FDM stands for Frequency Division Multiplexing. It is a scheme in which several channels are interleaved and then transmitted together.

24. **Compare TDM and FDM. [D]**

FDM	**TDM**
The signals which are to be multiplexed are added in the time domain. But they occupy different slots in the frequency domain.	The signals which are to be multiplexed can occupy the entire bandwidth in the time domain
It is usually preferred for the analog signals	It is preferred for the digital signals
Synchronization is not required	Synchronization is required
It suffers from the problem of crosstalk due to imperfect BPF.	In this the problem of crosstalk is not severe.

25. **Which modulation system is inherently most noise resistant? [D]**
Pulse code modulation is inherently most noise resistant modulation system.

26. **What do you mean by sampling of a signal? [D]**

In a sampling process, continuous time signal is converted to an equivalent discrete time signal.

27. **Define Nyquist rate? [D]**

When the sampling rate becomes exactly equal to 2fm samples/sec, for a signl bandwidth fm. Hence then it is called Nyquist rate.

It is the minimum sampling rate required to represent the continuous signal faithfully in its sampled form.

f_s = 2fm samples/sec

28. **Define Nyquist interval? [D]**

Or

Define Nyquist Criteria. [D]

It is the time interval between any two adjacent samples when sampling rate is Nyquist Rate.

The maximum interval of sampling can be given as,

$T_{smax} = 1/f_{smin}$

$= 1/2f_{m}$.

29. **How are channels separated in a TDM receiver? [D]**

In order to transmit a number of these signals over the same channel, the signals must kept apart so that they do not interfere with each other, and hence they can be separated easily at the receiver end.

30. **Consider the analog signal x (t) = 3cos 50πt + 10sin 300πt – cos100πt. What is the Nyquist rate for this signal? [ID]**

$f_1 = 25Hz,\ 50\pi t = \omega 1t = 2\pi f_1 t = 2\pi*25t$

$f_2 = 150Hz,\ 300\pi t = \omega 2t = 2\pi f_2 t = 2\pi*150t$

$f_3 = 50\ Hz,\ 100\pi t = \omega 3t = 2\pi f_3 t = 2\pi*50t$

f2 = 150Hz

Nyquist Rate = 2W

W = f2 Hz

= 2 *150

W = 300 Hz

fs should be greater than Nyquist rate   fs > 300Hz.

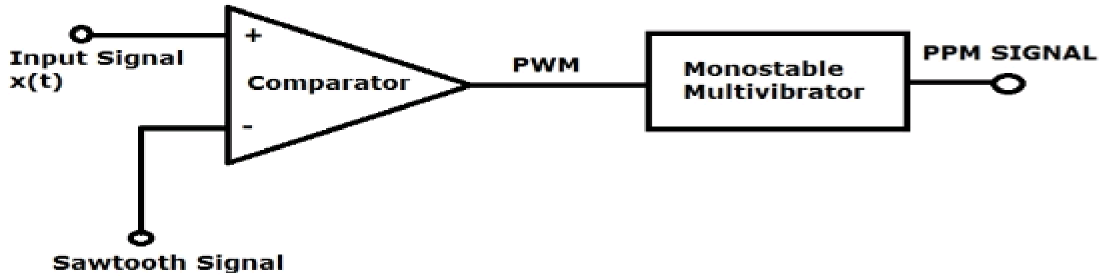
31. **What is the need for TDM system? [ID]** **[Apr - 2019]**

A *time-division multiplex* (TDM) *system*, which enables the joint utilization of a common communication channel by a plurality of independent message sources without mutual interference among them.

32. **Define sampling rate. [Apr - 2019] [D]**

The band pass signal represented into and recovered the bandwidth $g(t)$ whose maximum bandwidth is $2W$ can be completely from its samples if it is sampled at the minimum rate of twice.

33. Draw the schematic diagram to generate PPM from PWM.(Nov/Dec 2019)



Generation of PPM Signal

34. In a PCM, 6bit encoder has been replaced by 8 bit encoder. Calculate SNR.(Nov/Dec 2019)

For 8-bit encoding, $L = 2^n$ where $n = 8$, therefore, the number of levels = 256. The amplitude A_m of the sinusoidal waveform means that $m_p = 2$ volts. The total signal swing possible ($-m_p$ to $+m_p$) will be $2m_p = 4$ volts, therefore, the average signal power is $P_{ave} = [(A_m)^2/2] = [2^2/2] = 2$ watts.

The interval $\Delta = [2m_p/L] = 4$ volts/256 levels $= 1.5625 \times 10^{-2}$ volt.

Now we can find the SNR (signal-to-quantized noise ratio)

Using for the quantization noise $N_q = [\Delta^2/12]$, and taking $P_{ave} = 2$ W, the SNR is given by

$$\left(\frac{S_O}{N_q}\right) = \left(\frac{P_{ave}}{N_q}\right) = \left(12\frac{2}{\Delta^2}\right) = \left(\frac{24}{(1.5625\times10^{-2})^2}\right) = 98,304$$

$$SNR_{dB} = 10\cdot\log_{10}(98,304) = 49.93 \text{ dB} \quad \Leftarrow$$

PART B

[1st Half]

Low pass sampling – Aliasing- Signal Reconstruction

1. What is meant by sampling? Explain. (13) **[D]**

   Or

   State and prove sampling theorem. (13) **[D]**

   Or

   Explain the sampling theorem for low pass signals? (13) **[D]**
2. Define explain Nyquist rate and Nyquist Interval? (7) **[D]**
3. Explain in detail about various sampling techniques with neat diagram? (13) **[D]**
4. What is aliasing and Explain how it can be avoided? (6) **[D]**
5. A band pass signal has the spectral range that extends from 20 kHz to 82 kHz. Find the acceptable range of sampling frequency f_s. (7) **[ID]**

Quantization - Uniform & non-uniform Quantization - quantization noise

6. Define quantization and describe the process of quantization? (7) **[D]**
7. Describe uniform quantization with neat diagram? (7) **(Nov/Dec 2019)** **[D]**
8. Describe non-uniform quantization with neat diagram? (7) **[D]**
9. Explain in detail about quantization and quantization error in digital communication? (7) **[D]**

[2nd Half]

Logarithmic Companding -PAM, PPM, PWM, PCM

10. What are the various pulse modulation methods? Explain. (13) **[D]**

    Or

    Explain in detail about various analog pulse modulation methods? (13) **[D]**
11. Explain the principle of operation of pulse code modulation. (7) **(Nov/Dec 2019)** **[D]**

12. Explain in detail about the principle of operation of pulse amplitude modulation. (7) **[D]**
13. Explain in detail about the principle of operation of pulse width modulation. (7) **[D]**
14. Explain in detail about the principle of operation of pulse position modulation. (7) **[D]**
15. Compare the performance of PCM, PPM, PAM, and PWM in all aspects? (6) **[ID]**
16. A voice signal is sampled at Nyquist state and each sample is quantified into one of 256 levels. Determine the output rate of PCM signal. (7) **[ID]**
17. Explain in detail about logarithmic Companding technique with neat diagram? (7) **[D]**

TDM, FDM.

18. What is multiplexing? Explain in detail of necessity of multiplexing? (7) **[D]**
19. Explain FDM technique with a neat block diagram? (7) **[D]**
20. Explain TDM technique with a neat block diagram? (7) **[D]**
21. Compare TDM and FDM? (6) **[D]**