Subject Name: ANALOG AND DIGITAL COMMUNICATION

Prepared by (Faculty (s) Name): Mrs. K.VANISREE

Year and Sem, Department: II Year II Sem ECE Dept.

Course Objectives:

- To develop ability to analyze system requirements of analog and digital communication systems.
- To understand the generation, detection of various analog and digitalmodulation techniques.
- To acquire the poetical knowledge of each block in AM, FM transmitters and receivers.
- To understand the concepts of baseband transmissions.

Course Outcomes:

- Analyze and design of various continuous wave and angle modulation and demodulation techniques
- Understand the effect of noise present in continuous wave and angle modulation techniques.
- Attain the knowledge about AM , FM Transmitters and Receivers Analyze and design the various Pulse Modulation Techniques.
- Understand the concepts of Digital Modulation Techniques and Baseband transmission

UNIT-I Amplitude Modulation: Need for modulation, Amplitude Modulation - Time and frequency domain description, single tone modulation, power relations in AM waves, Generation of AM waves Switching modulator, Detection of AM Waves - Envelope detector, DSBSC modulation - time and frequency domain description, Generation of DSBSC Waves - Balanced Modulators, Coherent detection of DSB-SC Modulated waves, COSTAS Loop, SSB modulation - time and frequency domain description, frequency discrimination and Phase discrimination methods for generating SSB, Demodulation of SSB Waves, principle of Vestigial side band modulation.

UNIT-II Angle Modulation: Basic concepts of Phase Modulation, Frequency Modulation: Single tone frequency modulation, Spectrum Analysis of Sinusoidal FM Wave using Bessel functions, Narrow band FM, Wide band FM, Constant Average Power, Transmission bandwidth of FM Wave Generation of FM Signal- Armstrong Method, Detection of FM Signal: Balanced slope detector, Phase locked loop, Comparison of FM and AM., Concept of Pre-emphasis and de-emphasis.

UNIT-III Transmitters: Classification of Transmitters, AM Transmitters, FM Transmitters Receivers: Radio Receiver - Receiver Types - Tuned radio frequency receiver, Superhetrodyne receiver, RF section and Characteristics - Frequency changing and tracking, Intermediate frequency, Image frequency, AGC, Amplitude limiting, FM Receiver, Comparison of AM and FM Receivers.

UNIT-IV Pulse Modulation: Types of Pulse modulation- PAM, PWM and PPM. Comparison of FDM and TDM. Pulse Code Modulation: PCM Generation and Reconstruction, Quantization Noise,

Non-Uniform Quantization and Companding, DPCM, Adaptive DPCM, DM and Adaptive DM, Noise in PCM and DM.

UNIT-V Digital Modulation Techniques: ASK- Modulator, Coherent ASK Detector, FSK- Modulator, NonCoherent FSK Detector, BPSK- Modulator, Coherent BPSK Detection. Principles of QPSK, Differential PSK and QAM. Baseband Transmission and Optimal Reception of Digital Signal: A Baseband Signal Receiver, Probability of Error, Optimum Receiver, Coherent Reception, ISI, Eye **Diagrams.**

TEXTBOOKS:

1. Analog and Digital Communications – Simon Haykin, John Wiley, 2005.
2. ElectronicsCommunication Systems-Fundamentals through Advanced-Wayne Tomasi, 5th Edition, 2009, PHI.

REFERENCE BOOKS:

1. Principles of Communication Systems -Herbert Taub, Donald L Schilling, Goutam Saha, 3rd Edition, McGraw-Hill, 2008.
2. Electronic Communications – Dennis Roddy and John Coolean , 4th Edition , PEA, 2004
3. Electronics& Communication System – George Kennedy and Bernard Davis, TMH 2004
4. Analog and Digital Communication – K. Sam Shanmugam, Willey ,2005

Unit I Amplitude Modulation

Important points / Definitions:

1. Definition of *amplitude modulation:* modulation of the amplitude of a radio carrier wave in accordance with the strength of the audio or other signal

2. *Broadcast transmissions:* AM is still widely used for broadcasting on the long, medium and short wave bands. It is simple to demodulate and this means that radio receivers capable of demodulating amplitude modulation are cheap and simple to manufacture. Nevertheless many people are moving to high quality forms of transmission like frequency modulation, FM or digital transmissions.

3.Air band radio: VHF transmissions for many airborne applications still use AM.

4. *Single sideband:* Amplitude modulation in the form of single sideband is still used for HF radio links. Using a lower bandwidth and providing more effective use of the transmitted power this form of modulation is still used for many point to point HF links.

5. Types of Amplitude Modulation

There are three main types of amplitude modulation. They are;

- Double sideband-suppressed carrier modulation (DSB-SC).
- Single Sideband Modulation (SSB).
- Vestigial Sideband Modulation (VSB).

6. Analogue electronic signal

$$\left.\begin{array}{c} m(t) = A_m \cos(\omega_m t + \theta) \\ (or) \\ m(t) = A_m \sin(\omega_m t + \theta) \end{array}\right\}$$

7. Need Modulation?

Practically speaking, modulation is required for;

- High range transmission
- Quality of transmission
- To avoid the overlapping of signals.

8. Amplitude Modulated Wave $\frac{A_m}{A_c} = \mu = \text{mod } ulation\ index$

$$\sin A \sin B = \tfrac{1}{2}[\cos(A-B) - \cos(A+B)] = A_c \sin\omega_c t + A_c\mu\tfrac{1}{2}[\cos(\omega_c - \omega_m) - \cos(\omega_c + \omega_m)]$$
$$c_m(t) = A_c \sin\omega_c t + \tfrac{A_c\mu}{2}\cos(\omega_c - \omega_m) - \tfrac{A_c\mu}{2}\cos(\omega_c + \omega_m) \ldots\ldots 3$$

9. Bandwidth of DSBSC Wave BW=f_{max}-f_{min}

$$P_t = \frac{{A_m}^2 {A_c}^2}{8R} + \frac{{A_m}^2 {A_c}^2}{8R}$$

$$\Rightarrow P_t = \frac{{A_m}^2 {A_c}^2}{4R}$$

Short Questions (minimum 10 previous JNTUH Questions – Year to be mentioned)

1. Define Modulation index and percent modulation for an AM wave. [May 2016]

For AM Modulation (Amplitude Modulation): "Modulation Index is defined as the relationship between the amplitude of the Information signal and the amplitude of the carrier signal".Modulation Index is the ratio.m=Vm/Vc

Where: Vm is the amplitude voltage of modulating (Information) signal. And Vc is the amplitude voltage of carrier signal.

Multiplying the ratio of modulation index by 100 gives the percentage modulation.

m=Vm/Vc*100

2. Give the classification of modulation. **[May 2016]**

Modulation techniques are roughly divided into four types: Analog modulation, Digital modulation, Pulse modulation , and Spread spectrum method. Analog modulation is

typically used for AM, FM radio, and short-wave broadcasting. Digital modulation involves transmission of binary signals (0 and 1).

3. Give the mathematical equation for a SSB modulated signal. [May 2016]

Modulating signal $m(t)=A_m\cos(2\pi f_m t)$

Carrier signal $c(t)=A_c\cos(2\pi f_c t)$

Mathematically, we can represent the equation of SSBSC wave as

$s(t)=A_mA_{c2}\cos[2\pi(f_c+f_m)t]$ for the upper sideband

Or

$s(t)=A_mA_{c2}\cos[2\pi(f_c-f_m)t]$ for the lower sideband

4. Why SSB transmission is the preferred than DSB-SC? [May 2016]

- Less bandwidth requirement as **SSB** requires a BW of fm . This will allow more number of signals to be transmitted in the same frequency range.
- Lots of power saving. This is due to the transmission of only one sideband component . ...
- Reduced interference of noise

5. Explain the need for modulation. Nov/Dec 2016]

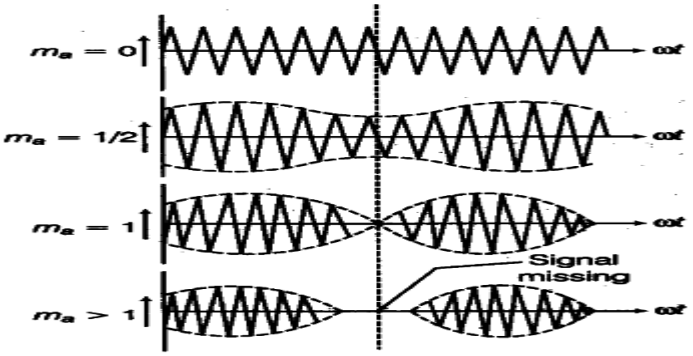
1. Reduction in the height of antenna
2. Avoids mixing of signals
3. Increases the range of communication
4. Multiplexing is possible
5. Improves quality of reception

6. Calculate the percentage saving in power if only one side band transmission is used over the DSB-SC system at (i) 100% modulation (ii) 50% modulation **[Nov/Dec 2016]**

7. What is Amplitude modulation? Define modulation index of an AM signal. [Nov 2015]

In amplitude modulation, the amplitude (signal strength) of the carrier wave is varied in proportion to that of the message signal being transmitted. degrees of modulation
Under modulation. m<1
Critical modulation m=1
Over modulation m>1

8. Draw the Amplitude Modulation waveforms with modulation index (m)=1, m<1, m>1.



[Nov 2015]

9. Compare AM with DSB-SC and SSB-SC. [Nov 2015][Mar 2017][Nov/Dec 2018]

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

10 For 100% modulation what is the relationship between the voltage amplitudes of the side ban**d. [Nov 2015]**

12. Write the expression for amplitude modulated wave. [Mar 2017]

Amplitude Modulation

- The amplitude of high-carrier signal is varied according to the instantaneous amplitude of the modulating message signal m(t).

Carrier Signal: $\cos(2\pi f_c t)$ or $\cos(\omega_c t)$
Modulating Message Signal: $m(t)$: $\cos(2\pi f_m t)$ or $\cos(\omega_m t)$
The AM Signal: $s_{AM}(t) = [A_c + m(t)]\cos(2\pi f_c t)$

CSULB May 22, 2006 6

13. What are the methods for detecting AM waves? [Mar 2017]

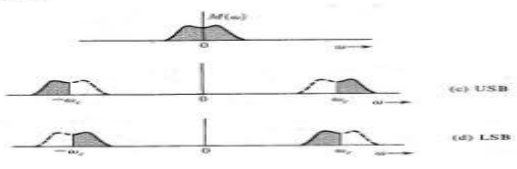
For amplitude modulation, detectors or demodulators are categorized as,

a) Square-law detectors b) Envelope detectors

14. Draw the frequency domain representation of SSB modulated wave. [Mar 2017]

Single-Sideband (SSB) Modulation

- In single-sideband (SSB) modulation just only one sideband is transmitted.



16. Define analog Modulation and also, list different types of analog modulations**. [Dec 2018]**
17. Define Modulating Signal, Carrier and Modulated Signals**. [Dec 2018]**
18. What is Guard band? **[Dec 2018]**
19. Compare SSB and VSB. [Dec 2018]

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.

20. What are the advantages of Ring Modulator [Nov/Dec 2018]

1. Its output is stable.2. It requires no external power source to activate the diodes.
3...Virtually no maintenance.4. Long life.

21. What is difference between coherent and non- coherent demodulation [Nov/Dec 2018]

Coherent systems need carrier phase information at the receiver and they use matched filters to detect and decide what data was sent , while noncoherent systems do not need carrier phase information and use methods like square law to recover the data.

22. What are the advantages of single side band transmission [Nov/Dec 2018]

As the carrier is not transmitted, this enables a 50% reduction in transmitter power level for the same level of information carrying signal. ... As only one sideband is transmitted there is a further reduction in transmitter power.

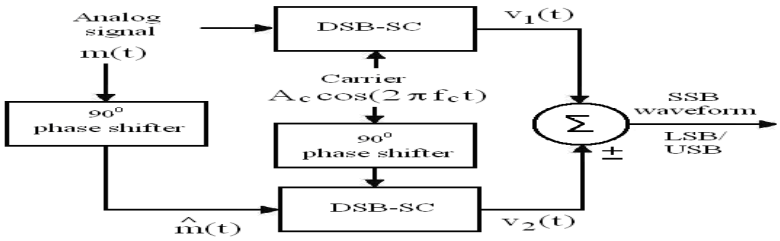
24. A modulating signal consists of a symmetrical triangular wave, which has zero dc component and peak-to-peak voltage 11v. It is used to amplitude modulate a carrier of peak voltage 10v. Find the modulation index**? [May 2019]**

25.The antenna current of an AM transmitter is 8 Amps, when only the carrier is sent, but it increases to 8.93A, when the carrier is modulated by a single sine wave. Find percentage modulation. Determine the antenna current when the percent modulation changes to 0.8. **[May 2019]**

26.List the properties of Hilbert Transform. **[May 2019]**

The Hilbert transform is a standard method for the calculation of the envelope and phase of a modulated signal

27.Illustrate the block diagram for the detection of SSB-SC signal using phase discrimination method. **[May 2019]**



Long Questions (minimum 10 previous JNTUH Questions – Year to be mentioned)

1. Explain the detection of DSB-SC wave using a) Synchronous detector b) Costas loop **[May 2016].[Nov/Dec 2018]**

2. Explain the method of generating AM waves using linear time invariant circuits and by using non linear circuits. **[May 2016]**

3. Show that an SSB signal can be demodulated by the synchronous detector by sketching the spectrum of the signal at each point and by the time domain expression of the signals at each point. [**May 2016]**

4.A carrier wave of a frequency of 20 kHz is amplitude-modulated by a modulating signal f(t)=cos 2π103 t+cos 4π103 t. Find the expression for the corresponding SSBSC signal. **[May 2016]**

5. Define modulation and explain the need of modulation. b) A carrier with amplitude modulated to a depth of 50% by a sinusoidal, produces side band frequencies of 5.005 MHz and 4.995MHz. The amplitude of each side frequency is 40V. Find the frequency and amplitude of the carrier signal.
[Nov/Dec 2016]

6. Draw the block diagram and explain generation of DSB-SC signal using balanced modulator.
b) A modulating signal is a multi-tone signal given by m(t) = A1 cosw1t+A2 cosw2t+A3 cosw3t. The signal m (t) modulates a carrier Ac coswct. Plot the signal sided spectrum and find the bandwidth of the modulating signal. Assume that w3>w2>w3 and A3>A2>A1. **[Nov/Dec 2016]**

7. What is SSB Modulation and what are its advantages? Draw the block diagram for SSB generation using Phase discrimination method and explain its operation.
b) Explain how the base band signal can be recovered from the VSB Signal plus carrier using envelope detector **[Nov/Dec 2016]**

8. Mention applications of different AM Systems.
b) A vestigial filter has a transfer function H (f) with fc = 105Hz. Find the VSB modulated signal when e m(t) = cos (2πfmt) and e c(t) = 2cos(2πfct). Assume fm=103Hz. **[Nov/Dec 2016]**

9. What is the principle of amplitude modulation? Derive expression for the AM wave and draw its spectrum**.** **[Nov 2015]**

10. For an Am DSBFC wave with peak unmodulated carrier voltage Vc=10Vp, a load resistance RL= 10 Ω and a modulation co efficient m = 1.
Determine a) Power of carrier, upper and lower side band b) Total power of modulate wave c) Total sideband power d) Draw the power spectrum .With a neat diagram explain how a SSB wave is generated using Phase Discriminator method with only USB and rejecting the LSB **[Nov 2015]**

11. Derive an expression for SSB Modulated wave for which upper sideband is retained. **[Nov 2015]**

12. Derive the relation between the output power of an AM transmission and the depth of modulation.
b) When the modulation percentage is 75, an AM transmitter produces 10KW. How much of this is carrier power. What would be the percentage power saving if the carrier and one of

the side bands were suppressed? **[Mar 2017][Nov/dec 2018]**

13. Draw the circuit diagram for balanced ring modulator and explain its operation indicating all the waveforms of the modulator.

b) What is the effect of frequency and phase error in demodulation of DSB-SC wave using synchronous detector. **[Mar 2017]**

14. Discuss various methods used to generate SSB signals with neat sketches.

b) Explain the need of VSB modulation. **[Mar 2017]**

15. Describe the time domain band-pass representation of VSB. Draw and explain the block diagram of VSB generation corresponding to the time domain description**[Mar 2017][Dec 2018]**

16. Explain Am Detection using envelope detector . How is the RC time constant chosen for envelope detection?

b. Obtain expression for sideband power in an AM signal for singe tone modulation **[Nov/Dec 2017][May 2019]**

17. Explain how a ring modulator is used for generation of DSB-SC waves

b. Draw the block diagram of an AM transmitter and explain the need and functioning of each of its block **[Nov/Dec 2017]**

18. What are the demerits of filter method of SSB generation? Explain how they are overcome in phase discriminator method

b. compare AM,DSBSC,SSB,VSB modulation schemes **[Nov/Dec 2017]**

19. With the help of waveforms and spectrum, describe the concept of Amplitude modulation both in time domain and frequency domain. b) Describe the coherent detection of DSB-SB modulated waves. [**Dec 2018]**

20.With necessary circuit diagram and waveforms, explain how DSB-SC wave is generated using: i) Balance Modulators and ii) Ring Modulator.

b) When a broadcast AM transmitter is 50 percent modulated, its antenna current is 12 A. What will be current when the modulation depth is increased to 0.9? [**Dec 2018]**

21.Describe the SSB in frequency domain and then explain how to generate SSB modulated wave using frequency discrimination method. Also, list the advantages of SSB. [**Dec 2018] [Nov/Dec 2018]**

22 Give the applications of AM-FC and VSB modulation schemes. [**Dec 2018]**

23.Explain the generation of Switching modulator

b. What is the effect of frequency and phase over error in demodulation of DSB SC wave using synchronous detector **[Nov/Dec 2018]**

24.Discuss the generation of AM waves in square law modulator in detail **[Nov/Dec 2018]**

b. A carrier with amplitude modulated to a depth of 50% by a sinusoidal produces side band frequencies of 5.005 Mhz. the amplitude of each side frequencyin 40 v. Find the frequency and amplitude of the carrier signal **[Nov/Dec 2018]**

25. Explain the generation of AM SSB Modulated waves phase discrimination method

b. Explain how the base band signal can be recovered from the VSB signal plus carrier using envelope detector **[Nov/Dec 2018][May 2019]**

26. Why VSB modulation is used in TV broad casting? Give the VSB filter characteristics with spectrum**.**
[May 2019]
27. Explain the necessity of modulation in communication system and mention about Amplitude Modulation with its bandwidth requirements and calculate the modulation index of in terms of vmax and vmin voltages
[Nov/Dec 2018]
28. Describe the main benefits of SSB over conventional AM methods **[Nov/Dec 2018]**

Unit I
Fill in the Blanks / Choose the Best: (Minimum 10 to 15 with Answers)

1 Amplitude modulation is
a. Change in amplitude of the carrier according to modulating signal
b. Change in frequency of the carrier according to modulating signal
c. Change in amplitude of the modulating signal according to carrier signal
d. Change in amplitude of the carrier according to modulating signal frequency **[a]**

2. The ability of the receiver to select the wanted signals among the various incoming signals is termed as
a. Sensitivity
b. Selectivity
c. Stability
d. None of the above **[b]**

3.Emitter modulator amplifier for Amplitude Modulation
a. Operates in class A mode
b. Has a low efficiency
c. Output power is small
d. All of the above **[d]**

4.Super heterodyne receivers
a. Have better sensitivity
b. Have high selectivity
c. Need extra circuitry for frequency conversion
d. All of the above
[d]

5. The AM spectrum consists of
a. Carrier frequency
b. Upper side band frequency
c. Lower side band frequency
d. All of the above **[d]**

6. The function of multiplexing is
a. To reduce the bandwidth of the signal to be transmitted
b. To combine multiple data streams over a single data channel
c. To allow multiple data streams over multiple channels in a prescribed format
d. To match the frequencies of the signal at the transmitter as well as the receiver **[b]**

7. **Aliasing refers to**
a. Sampling of signals less than at Nyquist rate
b. Sampling of signals greater than at Nyquist rate
c. Sampling of signals at Nyquist rate
d. None of the above **[a]**

8. **The amount of data transmitted for a given amount of time is called**
a. Bandwidth
b. Frequency
c. Noise
d. Signal power **[b]**

9. **The total power in an Amplitude Modulated signal if the carrier of an AM transmitter is 800 W and it is modulated 50 percent.**
a. 850 W
b. 1000.8 KW
c. 750 W
d. 900 W **[d]**

10.Vestigial side band signals are detected by
a. Filters
b. Synchronous detection
c. Balanced modulator
d. None of the above **[b]**

11. Standard intermediate frequency used for AM receiver is 455 MHz]

12.In the TV receivers, the device used for tuning the receiver to the incoming signal is [Varactor diode]

13. The modulation technique that uses the minimum channel bandwidth and transmitted power is [SSB]

14. Calculate the bandwidth occupied by a DSB signal when the modulating frequency lies in the range from 100 Hz to 10KHz. [19.8 Khz]

15.A modulation index of 0.5 would be same as [50% of Modulation Depth]

16.A 3 GHz carrier is DSB SC modulated by a signal with maximum frequency of 2 MHz. The minimum sampling frequency required for the signal so that the signal is ideally sampled is [6.004 GHz]

17. Generation of SSB SC signal is done by [Phase discrimination method & Frequency discrimination method]

18. AM demodulation techniques are [Square law demodulator &Envelope detector]

19. **Examples of low level modulation are [Square law diode modulation& Switching modulation]**

20. Calculate the depth of modulation when a transmitter radiates a signal of 9.8KW after modulation and 8KW without modulation of the signal [67%]

Unit II
Important points / Definitions:

1.The FM modulation index is equal to the ratio of the frequency deviation to the modulating frequency.

$$m = \frac{Frequency\ deviation}{Modulation\ frequency}$$

2. *Wideband FM:* Wideband FM is typical used for signals where the FM modulation index is above 0.5. For these signals the sidebands beyond the first two terms are not insignificant

3. *Narrowband FM:* Narrow band FM, NBFM, is used for signals where the deviation is small enough that the terms in the Bessel function is small and the sidebands are negligible.

4. Carson's Rule can be expressed simply as a formula: $BT = 2(\Delta f + fm)$
5. Phase locked loop, PLL FM detectors can easily be made from the variety of phase locked loop integrated circuits that are available, and as a result, PLL FM demodulators are found

6. The **frequency modulation** can be defined as; the frequency of the carrier signal is varied proportional to (in accordance with) the Amplitude of the input modulating signal.
7. The **modulation index of FM** is defined as the ratio of the frequency deviation of the carrier to the frequency of the modulating signal
mf = Modulation Index of FM = Δf/fm
8. The term PM or **phase modulation definition** is a type of modulation intended for transmitting communication signals. It changes message signal in accordance with the carrier signal due to differences in the immediate phase.
9. Phase modulation is calculated by adding the baseband signal to the argument of a sine or cosine function that represents the carrier.
10. The modulation index makes the phase variations more or less sensitive to the behavior of the baseband signal.

Short Questions (minimum 10 previous JNTUH Questions – Year to be mentioned)

1. What are the two methods of producing an FM wave? [May 2016]
FM radio uses frequency modulation, of course. The frequency band for FM radio is about 88 to 108 MHz. The information signal is music and voice which falls in the audio spectrum. The full audio spectrum ranges form 20 to 20,000 Hz, but FM radio limits the upper modulating frequency to 15 kHz
2. What are the applications of phase locked loop? [May 2016]

Demodulation of frequency modulation (FM): If PLL is locked to a FM signal, the VCO tracks the instantaneous frequency of the input signal. The filtered error voltage which controls the VCO and maintains lock with the input signal is demodulated FM output. The VCO transfer characteristics determine the linearity of the demodulated out. Since, VCO used in IC PLL is highly linear, it is possible to realize highly linear FM demodulators

3. What is threshold effect in envelope detector? [Nov/Dec 2016][Dec 2018]

It is defined as the value of input signal to noise ratio below which the output signal to noise ratio decreases much rapidly than the input signal to noise ratio. It is the property of **envelope detectors** used for the demodulation of modulated signals.

4. Define the terms frequency deviation and modulation index for FM wave[Nov/Dec 2016] [Mar 2017] [May 2019]

The FM modulation index is equal to the ratio of the frequency deviation to the modulating frequency.

m=Frequency deviation / Modulation frequency

the FM deviation ratio can be defined as: the ratio of the maximum carrier frequency deviation to the highest audio modulating frequency.

m=Max frequency deviation / Max modulation frequency

5. What are the similarities and differences between narrowband FM and AM system **[Nov/Dec 2016] [Mar 2017][Dec 2018]**

Amplitude Modulation (AM)	Frequency Modulation (FM)
First successful audio transmission was carried out in the mid-1870s	Developed in 1930 by Edwin Armstrong, in the United States
The radio wave is called a carrier wave and the frequency and phase remain the same	The radio wave is called a carrier wave, but the amplitude and phase remain the same
Has poor sound quality, but can transmit longer distance	Has higher bandwidth with better sound quality
The frequency range of AM radio varies from 535 to 1705 kHz	The frequency range of FM is 88 to 108 MHz in the higher spectrum
More susceptible to noise	Less susceptible to noise

6. Define the term modulation index for AM and FM **[Nov 2015]**

7. Derive the formula for instantaneous value of FM voltage **[Nov 2015]**

8. What is the need of pre-emphasis and de-emphasis in FM transmission? **[Nov 2015]**

11. In an FM system, if mf is doubled by halving the modulating frequency, what will be the effect on the maximum deviation**?** **[Dec 2018]**

12. What When a carrier is Frequency modulated, the output signal has the frequency deviated above and below the carrier frequency, this is known as Frequency Deviation. When the FM signal is passed through a mixer, the mixer changes the carrier frequency but the deviation remains unchanged **[Nov/Dec 2018]**

14. How do you vary the frequency deviation [Nov/Dec 2018]

When a carrier is Frequency modulated, the output signal has the frequency deviated above and below the carrier frequency, this is known as Frequency Deviation. When the FM signal is passed through a mixer, the mixer changes the carrier frequency but the deviation remains unchanged

15. Define bandwidth of FM. [May 2019]

The bandwidth of a FM signal may be predicted using:

$$BW = 2(\beta + 1) f_m$$

where β is the modulation index and

f_m is the maximum modulating frequency used.

16. Compare NBFM and WBFM **[May 2019]**

NBFM uses a small amount of deviation, WBFM uses a large amount. ... NBFM uses a small amount of deviation, WBFM uses a large amount. Modulating a carrier signal produces sidebands, which are a complex mixture of frequencies either side of the carrier frequency

Long Questions (minimum 10 previous JNTUH Questions – Year to be mentioned

1. Which method of FM signal generation is the preferred choice, when the stability of the carrier frequency is of major concern? Discuss about the method in detail.
b) Compare FM and AM systems. **[May 2016]**

2. A single tone modulating signal cos(10π103 t) frequency modulates a carrier of 10 MHz and produces a frequency deviation of 75 kHz. Find:
a) the modulation index and
b) phase deviation produced in the FM wave.
c) if another modulating signal produces a modulation index of 100 while maintaining the same deviation, find the frequency and amplitude of the modulating signal, assuming K_f =10 kHz/V **[May 2016]**

3.Discuss the effect of modulation index on the band width of FM. Explain the generation of WBFM from NBFM with neat sketch.
b) A carrier is frequency modulated by a sinusoidal modulating of frequency 2 kHz, resulting in a frequency deviation of 5 kHz. What is the bandwidth occupied by the modulated waveform? The amplitude of the modulating sinusoid is increased by a factor 2 and its frequency lowered by 500Hz. What is the new bandwidth? **[Nov/Dec 2016]**

4. Compare the direct and indirect methods of generating FM signals. Explain Armstrong method of generating FM signals with a neat block schematic diagram.
b) Draw the spectral representation of FM wave and derive the expression the Transmission bandwidth. **[Nov/Dec 2016]**

5. Explain the principle of Angle Modulation. Derive and explain phase deviation, Modulation index, frequency deviation and percent modulation**.** **[Nov 2015].[May 2019]**

6. Derive the expression for the frequency modulated signal. Explain what is meant by narrowband FM and wideband FM using the expression.. **[Nov 2015**].
7, Draw and explain the pre-emphasis and de-emphasis circuits with a neat diagram. What is their function? **[Nov 2015**].
8. Derive the expression for FM signal from fundamentals and differentiate narrow band FM and wide band FM.

b) Explain the principle of direct method of generation of FM signal using relevant diagrams. **[Mar 2017]**

9.Prove that narrow band FM offers no improvement in SNR over AM. **[Mar 2017]**

10. For the modulated signal given below , determine i. Carrier frequency in radian/sec ii. Modulating frequency in radian/sec iii. Modulating index iv. Peak frequency derivation .Angle modulated signal is given as $V(t) = 20 \sin(3.28 * 10^6 t + 10 \sin(3,28 * 10^3 t)$

b. Show that the power delivered by an FM signal into a one ohm is constant **[Nov/Dec 2017]**

11. Explain FM detection using Foster-Seeley discriminator method

b. Draw the block diagram of FM transmitter and explain the need and function of each of its blocks **[Nov/Dec 2017]**

12. Discuss the detection of FM wave using zero crossing detector**.** **[Dec 2018]**

b) Discuss the generation of FM wave using direct method.

13. Analyze Sinusoidal FM wave with the help of its spectrum.

b) Explain how FM signal is detected with the help of PLLs**.** **[Dec 2018][May 2019]**

Fill in the Blanks / Choose the Best: (Minimum 10 to 15 with Answers)

1. In FM the carrier deviation is determined by

a) Modulating
(b) Frequency
(c) Either of the above
(d) None of the above **[a]**

2.In FM

(a) Noise decreases by increasing deviation
(b) Noise decreases by decreases deviation
(c) Noise decreases by maintaining deviation constant
(d) None of the above **[a]**

3.Which of the following oscillator is not in FM

(a) Crystal oscillator
(b) Hartley oscillator
(c) Colpitts oscillator
(d) All of the above **[a]**

4.The frequency of the stereo sub carrier signal in FM broadcasting is –

(a) 19 kHz
(b) 38 kHz
(c) 50 kHz
(d) 76 kHz **[b]**

5.The difference between phase and frequency modulation :

(a) Lies in the different definition of the modulation index
(b) Is too great to make the two systems compatible
(c) Is purely theoretical because they are the same in practice
(d) Lies in the poorer radio response of phase modulation index **[a]**

6.Which one of the following is not necessarily an advantage of FM over AM ?

(a) Better noise immunity is provided
(b) The transmitted power is more useful
(c) Lower bandwidth is required
(d) Less modulating power is required **[c]**

7.In FM, the frequency deviation is :
(a) Constant
(b) Zero
(c) Proportional to modulating frequency
(d) Proportional to amplitude of modulating signal **[d]**

8.In phase modulated signal, the frequency deviation proportional to :
(a) Frequency only
(b) Amplitude only
(c) Both a and b
(d) None of the above **[b]**

9.If signal band limited to fm is sampled at a rate less than 2 fm., the reconstructed signal will :
(a) Be smaller in amplitude
(b) Have higher frequencies suppressed
(c) Be distorted
(d) All the above **[c]**

10. Pre-emphasis circuit is used :
(a) Before detection
(b) After detection
(c) Before modulation
(d) After modulation **[c]**

11. What is the full form of AFC____ [Automatic frequency control]
12. FM is a part of general class of modulation known as _____ Angle modulation]
13. Which of the following are two most important classes of angle modulation [Frequency modulation, phase modulation]
14. FM bandwidth is approximated using _____ rule [Carson's]]

15. FM can be generated using PM by _____ .[Passing the modulating signal through a low pass filter]
16. Noise immunity of PM is _____ [Better than AM but worse than FM]
17. The frequency deviation in PM is proportional to _____.[Modulating frequency and voltage]
18. Amplitude of PM wave _____ [remain constant]
19. The equation for the modulated PM wave is given by____ [5 sin (2 $\pi \times 10^6$ t + 10 sin 6280 t]
20. With change in modulating frequency (f_m), the modulation index m_p of a phase modulated signal will _____. [remain constant]

Unit III
Important points / Definitions:
1. the term superheterodyne refers to creating a beat frequency that is lower than the original signal
2. the AM or FM signal which is centered on the carrier frequency to some intermediate value, called the IF (intermediate frequency)

3. The FM transmitter is a low power transmitter and it uses FM waves for transmitting the sound, this transmitter transmits the audio signals through the carrier wave by the difference of frequency. The carrier wave frequency is equivalent to the audio signal of the amplitude and the FM transmitter produce VHF band of 88 to 108MHZ.
4. To generate the radio frequency carrier waves the FM transmitter circuit requires an oscillator.
5. The FM radio transmitter has a 200kHz wide channel.
6. The maximum audio frequency transmitted in FM is 15 kHz as compared to 4.5 kHz in AM.
7. TRF receiver is a receiver where the tuning, i.e. selectivity is provided by the radio frequency stages.
8. The automatic gain control, AGC within a superhet radio enables the gain of the receiver to be controlled to level the audio output, but to prevent overloading.

9. A receiver with a poor level of image rejection will suffer from much higher levels of interference than one with a high level of image rejection. In view of this, radio receivers to be used in high performance radio communications applications need to have a good image rejection performance
10. Amplitude limiting is "a process in which the amplitude of output signal is limited to a desired level or margin irrespective of the variations in the input signal"
11. When the carrier-to-noise ratio decreases below a certain point. Below this critical point the signal-to-noise ratio decreases significantly. This is known as the FM threshold effect (FM threshold is usually defined as the carrier-to-noise ratio at which the demodulated signal-to-noise ratio fall 1 dB below

Short Questions (minimum 10 previous JNTUH Questions – Year to be mentioned

1. What is meant by sensitivity and selectivity of a communication receiver? [May 2016,2019]
Sensitivity and selectivity are very useful parameters for a wireless receiver. Receiver Sensitivity- It is the smallest possible signal power level at the input of a receiver which assures proper functioning of a wireless receiver i.e. it will decode data correctly.
2. Write a note on AGC [May 2015] [May 2016]
AGC is a departure from linearity in AM radio receivers. ... The AGC circuit keeps the receiver's output level from fluctuating too much by detecting the overall strength of the signal and automatically adjusting the gain of the receiver to maintain the output level within an acceptable range
3. Give the classification of radio transmitters. [Nov/Dec 2016]
1. The Amplitude-Modulated (AM) Transmitter and 2. Frequency-Modulated (FM) Transmitter. Normally, AM transmitters are used in medium wave and short wave zone, and FM transmitters are used in VHF and UHF ranges.
4.What is the need for AGC circuit [Mar 2017]
Automatic Gain Control (AGC) circuits are employed in many systems where the amplitude of an incoming signal can vary over a wide dynamic range. The role of the AGC circuit is to provide a relatively constant output amplitude so that circuits following the AGC circuit require less dynamic range.
5. Define amplitude limiting [Nov/Dec 2016]Nov/Dec 2018]

Amplitude limiting is "a process in which the amplitude of output signal is limited to a desired level or margin irrespective of the variations in the input signal"

6. Explain simple and delayed AGC [Nov/Dec 2016][Nov/Dec 2018]

AGC stands for Automatic Gain Control. In simple AGC, the level of amplification for radio or sound remains at the same level. Whereas, in delayed AGC the signal level increases and results in the increase in voltage of AGC which also increases the conduction

7 Explain the image frequency rejection of a radio receiver. [Mar 2017] [May 2019]

In heterodyne receivers, an image frequency is an undesired input frequency equal to the station frequency plus (or minus) twice the intermediate frequency. The image frequency results in two stations being received at the same time, thus producing interference

Long Questions (minimum 10 previous JNTUH Questions – Year to be mentioned

1. Explain the working of TRF receiver with its block diagram.**[May 2015,2016**] [**Nov/Dec 2017] [Mar 2017]**

2.In a broadcast super heterodyne receiver having no RF amplifier, the loaded Q of the antenna coupling circuit is 100. If the IF frequency is 455 kHz, determine the image frequency and its rejection ratio for tuning at 1.1. kHz stations **[May 2015**] [**May 2016]**

3. Draw and explain block diagram of double conversion FM receiver **[Nov 2015]**

4. What is AGC? Draw and explain a simple AGC circuit and what are the different types of AGC explain them. **[Nov 2015]**

5. Draw the AM receiver model and determine the signal to noise ratio of AM system. **[Nov/Dec 2016]**

6. Explain the operation of Superhetrodyne receiver with a neat schematic diagram.
b) Explain the terms: i) Automatic Gain Control (AGC). ii) Amplitude limiting iii) Squelch circuit. **[Nov/Dec 2016] [May 2019]**

7. Derive the equation for noise figure of FM receiver**.** **[Nov 2015]**

8. What is the purpose of pre-emphasis and de-emphasis filtering? Explain the filtering process with suitable sketches. **.**
[Nov 2015]

9. Give the comparison between phase discriminator and ratio detector [**Mar 2017]**

10. Define the term for a receiver selectivity, fidelity, and image frequency **[Nov/Dec 2017] [Dec 2018]**

11. Of all the frequencies that must be rejected by a superheterodyne receiver, why is the image frequency so important? What is the image frequency and how does it arise? If the image-frequency rejection of a receiver is insufficient, what steps could be taken to improve it? **[Dec 2018]**

12. Draw the block diagram of FM receiver and explain each block, briefly **[Dec 2018]**

Fill in the Blanks / Choose the Best: (Minimum 10 to 15 with Answers)

1Modulation is done in_____
a)Receiver
b)Transducer
c)Between transmitter and radio receiver
d) Transmitter **[d]**

2. In AM receiver the oscillator frequency is –

(a) Always equal to signal frequency
(b) Always equal to 455 kHz
(c) Always higher than signal frequency
(d) Always lower than signal frequency **[c]**

3. Which of the following receiver does not have amplitude limiter stage?
a) AM
(b) FM
(c) Both AM and FM
(d) None of these **[a]**

4. High intermediate frequency in a superheat receiver :
(a) Improves selectivity
(b) Increases tracking problems
(c) Reduces adjacent channel rejection
(d) All of the above **[b]**

5. The household radio receiver uses …….. detector.
(a) Envelope
(b) Radio
(c) Synchronous
(d) Any of the above **[a]**

6. Most of the amplification of the received signal is obtained in a super heterodyne receiver from the ……. Stage.
(a) IF
(b) RF
(c) Power amplifier
(d) None of the above **[a]**

7._____ Modulator is an indirect way of generating FM.
(a) Reactance FET
(b) Varactor FET
(c) Armstrong
(d) Reactance bipolar transistor **[c]**

8. If the output power of radio receiver is doubled, the volume is increased by…….
(a) – 3 dB
(b) 1 dB
(c) 2 dB
(d) 3 dB **[d]**

9. Receiver having poor if selectivity will have poor :
(a) Sensitivity
(b) Blocking
(c) Diverse reception
(d) All of the above **[b]**

10. Which of the following should be used to prevent overloading of the last 1 F amplifier in a receiver ?
(a) Double conversion
(b) Variable sensitivity
(c) Variable selectivity
(d) Squelch **[b]**

11. **In a transmitter ……. oscillator is used** [**Crystal]**
12. **In India, ……. modulation is used for radio transmission** [**Amplitude]**
13. **In an AM wave useful power is carrier by ……** [**Sidebands]**
14. **In amplitude modulation, bandwidth is ……the audio signal frequency [Twice]**
15**. Over modulation occurs when signal amplitude is ……carrier amplitude [Greater than]**
16. **In an AM wave, the majority of the power is in** …… [**Carrier**]
17. **At 100% modulation, the power in each sideband is ….. of that of carrier [25%]**
18. **In superhetrodyne receiver, the input at mixer stage is …….[RF and local oscillator signal]**
19. **When the modulating signal controls the frequency of the carrier, we get……[Frequency modulation]**
20. **The major advantage of FM over AM is ……..[Reception is less noisy**]

Unit IV
Important points / Definitions:

1.Pulse-code modulation (PCM) is a method used to digitally represent sampled analog signals. It is the standard form of digital audio in computers, compact discs, digital telephony and other digital audio applications.

2.Linear PCM (LPCM) is PCM with linear quantization.

3.DPCM encodes the PCM values as differences between the current and the predicted value. An algorithm predicts the next sample based on the previous samples, and the encoder stores only the difference between this prediction and the actual value. If the prediction is reasonable, fewer bits can be used to represent the same information. For audio, this type of encoding reduces the number of bits required per sample by about 25% compared to PCM.

4.Adaptive DPCM (ADPCM) is a variant of DPCM that varies the size of the quantization step, to allow further reduction of the required bandwidth for a given signal-to-noise ratio.

5Delta modulation is a form of DPCM which uses one bit per sample

.6.DM is the simplest form of differential pulse-code modulation (DPCM) where the difference between successive samples are encoded into n-bit data streams.

7.To achieve high signal-to-noise ratio, delta modulation must use oversampling techniques, that is, the analog signal is sampled at a rate several times higher than the Nyquist rate.

Basis for Comparison	PAM	PWM	PPM
Varying parameter	Amplitude	Width	Position
Immunity towards noise	Low	High	High
Signal to noise ratio	Low	Moderate	Comparitively high
Need of synchronization pulse	Not exist	Not exist	Exist
Bandwidth dependency	On pulse width	On rise time of pulse	On rise time of pulse
Transmission power	Variable	Variable	Constant
Bandwidth requirement	Low	High	High
Similarity of implementation	Similar to AM	Similar to FM	Similar to PM
Synchronization between Transmitter and Receiver	Not needed	Not needed	Needed

9. Pulse Duration modulation (PDM) or Pulse Length modulation (PLM).
10. The amplitude and position of the pulse remains constant for PWM signals. Thus PWM is more robust to noise than PAM.
11. Synchronization between transmitter and receiver is not required unlike pulse position modulation.
12. PWM signals can also be used for generating PPM signals.

Short Questions (minimum 10 previous JNTUH Questions – Year to be mentioned

1. Compare PCM and DM. [Oct/Nov 2016][May 2017]

S.NO	Parameter of Comparison	Pulse Code Modulation (PCM)	Delta Modulation (DM)
1.	Number of bits	It can use 4, 8, or 16 bits per sample.	It uses only one bit for one sample
2.	Levels and step size	The number of levels depends on number of bits. Level size is fixed.	Step size is kept fixed and cannot be varied.
3.	Quantization error and distortion	Quantization error depends on number of levels used.	Slope overload distortion and granular noise are present.
4.	Transmission bandwidth	Highest bandwidth is required since numbers of bits are high.	Lowest bandwidth is required.
5.	Feedback	There is no feedback in transmitter or receiver.	Feedback exists in transmitter.
6.	Complexity of Implementation	System is complex.	Simple

2. Write the advantages of digital communication. [Oct/Nov 2016]Dec 2018]

- The effect of distortion, noise, and interference is much less in digital signals as they are less affected.
- Digital circuits are more reliable.

- Digital circuits are easy to design and cheaper than analog circuits

3. State the sampling theorem. [Nov/Dec 2016] [Nov/Dec 2017][Apr 2018]

The sampling theorem can be defined as the conversion of an analog signal into a discrete form by taking the sampling frequency as twice the input analog signal frequency. Input signal frequency denoted by Fm and sampling signal frequency denoted by Fs**.**

4. What are the drawbacks of delta modulation? . [May 2016]

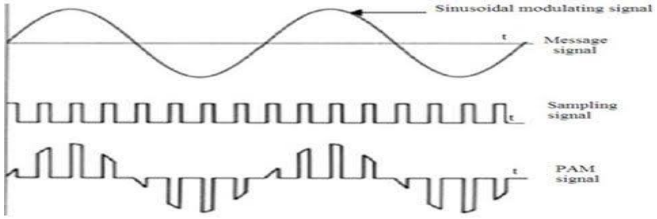
- Slope overload distortion. This distortion arises because of large dynamic range of input signal. ...
- Granular noise. Granular noise occurs when step size is too large compared to small variations in the input signal.

5. Explain the need for non-uniform quantization in digital communication [May 2016]

Non Uniform quantization because step size varies based on the message signal and it will be tracked with minimal amount of error**.**

6. Illustrate Single and double polarity PAM wave [Dec 2018]

Single polarity PAM is a situation where a suitable fixed DC bias is added to the signal to ensure that all the pulses are positive. Double polarity PAM is a situation where the pulses are both positive and negative**.**



7. What is slope overload distortion? Explain. [May 2017]

The input is rising faster than the delta modulation can follow. This is called "slope overload". It means that the slope of the input signal is greater than the maximum slope of the receiver, which is set by the choice of the increment or decrement and by the choice of sampling rate

8. What are merits of DPCM [Apr 2018]

1)Bandwidth Requirement Of Dpcm Is Less Compared To Pcm. 2) Quantization Error Is Reduced Because Of Prediction Filter. 3) Numbers Of Bits Used To Represent . One Sample Value Are Also Reduced Compared To Pcm

9. What is intersymbol interference in baseband binary PAM systems? [Apr 2018]

In baseband binary PAM, symbols are transmitted one after another. These symbols are separated by sufficient time durations. The transmitter, channel and receiver acts as a filter to this baseband data. Because of the filtering characteristics, transmitted PAM pulses are spread in time.

10, Define Nyquist Rate [May 2019]

The sample rate must exceed the Nyquist rate for the samples to suffice to represent x(t). The threshold $f_s/2$ is called the Nyquist frequency and is an attribute of the sampling equipment. All meaningful frequency components of the properly sampled x(t) exist below the Nyquist frequency**.**

11. What is meant by aliasing Effect [May 2019]

Aliasing is an effect that causes different signals to become indistinguishable (or *aliases* of one another) when sampled. It also often refers to the distortion or artifact that results when a signal reconstructed from samples is different from the original continuous signal..Aliasing can occur in signals sampled in time,

Long Questions (minimum 10 previous JNTUH Questions – Year to be mentioned

1.Explain why a single channel PPM of system requires the transmission of synchronization signal, where as a single channel PAM or PDM system does not require it. **[May 2016]**

2. What is the fundamental difference between pulse modulation, on one hand, and frequency and amplitude modulation on the other hand? . **[May 2016]**

3. Compare the pulse modulation systems and continuous modulation systems. b) What is Multiplexing? What are the advantages of Multiplexing? Explain how do you generate Time Division Multiplexing (TDM) signals. **[Nov/Dec 2016]**

4.What do you mean by pulse modulation and define types of pulse modulation? **[Nov 2015]**

5. With neat block diagram, Explain the process of Sampling and Quantization in digital communication. b) Derive the expression for the Quantization error. **[May 2016]**

6. Explain about the noise in PCM systems. b) Write the comparison between PCM and Analog modulation techniques. **[May 2016]**

7. Explain with a neat block diagram PPM generation and detection. **[Dec 2018][May 2019]**

b) Write short notes on time division multiplexing. **[Mar 2017][Nov/Dec 2017]**

8. Define and distinguish between PTM and PAM schemes. **[Dec 2018]**

9. Compare PAM, PWM and PPM pulse modulation techniques **[May 2019]**

10.With a neat sketch describe ADPCM concept **[Oct/Nov 2016][Dec 2018]**

11. Distinguish between analog communication and digital communication**. [Oct/Nov 2016]**

12.A voice frequency signal band limited to 3kHz is transmitted with the use of the DM system. The pulse repetition frequency is 30,000 pulses per second, and the step size is 40mV. Determine the permissible speech signal amplitude to avoid slope overload.

b) Derive the expression for overall SNR in a ADM system**. [May 2017]**

13.In a binary PCM system, the output signal to quantizing noise ratio is to be held to a minimum of 40dB. Determine the number of required levels and find the corresponding output signal to quantization noise ratio.

b) Explain the modulation and demodulation procedure in DPCM system **[May 2017]**

14. Draw the block diagram of digital communication system and explain each block in detail.

b) Mention the advantages of digital communication over analog communication.**[Apr 2018]**

15. Explain the term quantization.

b) Find the output signal power due to quantization noise in PCM system **[Apr 2018]**

16. Define Delta Modulation with neat sketch

b. Define PCM and explain **[Dec 2018]**

17. Explain the concept of Companding **or** A-Law and μ Law **[Dec 2018][May 2019]**

18. Write short notes on (i) Granular Noise (ii) Slope OverLoad Distortion **[May 2019]**

19. Derive the expression for quantization noise in delta modulation **[May 2019]**

Fill in the Blanks / Choose the Best: (Minimum 10 to 15 with Answers)

1. The modulation techniques used to convert analog signal into digital signal are
a. Pulse code modulation
b. Delta modulation
c. Adaptive delta modulation
d. All of the above **[d]**

2. Matched filters may be used
a. To estimate the frequency of the received signal
b. In parameter estimation problems
c. To estimate the distance of the object
d. All of the above **[d]**

3. The maximum data transmission rate in T1 carrier system is
a. 2.6 megabits per second
b. 1000 megabits per second
c. 1.544 megabits per second
d. 5.6 megabits per second **[c]**

4. In Adaptive Delta Modulation, the slope error reduces and
a. Quantization error decreases
b. Quantization error increases
c. Quantization error remains same
d. None of the above **[b]**

5. The digital modulation scheme in which the step size is not fixed is
a. Delta modulation
b. Adaptive delta modulation
c. DPCM
d. PCM **[b]**

6. In pulse width modulation,
a. Synchronization is not required between transmitter and receiver
b. Amplitude of the carrier pulse is varied
c. Instantaneous power at the transmitter is constant
d. None of the above **[a]**

7. In different types of Pulse Width Modulation,
a. Leading edge of the pulse is kept constant
b. Tail edge of the pulse is kept constant
c. Centre of the pulse is kept constant
d. All of the above **[d]**

8. In Pulse time modulation (PTM),
a. Amplitude of the carrier is constant
b. Position or width of the carrier varies with modulating signal
c. Pulse width modulation and pulse position modulation are the types of PTM
d. All of the above **[d]**

9. Pulse time modulation (PTM) includes
a. Pulse width modulation
b. Pulse position modulation
c. Pulse amplitude modulation
d. Both a and b **[d]**

10. In pulse amplitude modulation,
a. Amplitude of the pulse train is varied
b. Width of the pulse train is varied
c. Frequency of the pulse train is varied
d. None of the above **[a]**

11.Granular noise occurs when _____ [Step size is too large]

12.The factors that cause quantizing error in delta modulation are_____ [Slope overload and Granular noise]

13. The noise that affects PCM_____ [Transmission noise and Quantizing noise]

14. In Delta Modulation, the bit rate is_____ [N times the sampling frequency]

15. T1 carrier system is used_____ [For PCM voice transmission]

16. In PWM signal reception, the Schmitt trigger circuit is used____ [To remove noise]

17. Types of analog pulse modulation systems are _____[Pulse amplitude modulation]

18. The sampling technique having the minimum noise interference is____ [Natural sampling]

19. Calculate the Nyquist rate for sampling when a continuous time signal is given by x(t) = 5 cos 100πt +10 cos 200πt - 15 cos 300πt [300Hz]

20. Calculate the minimum sampling rate to avoid aliasing when a continuous time signal is given by x(t) = 5 cos 400πt [400 Hz]

Unit V

Important points / Definitions:

1.The unit of measurement is bits per second per Hz (b/s/Hz).

2. There are two types of AM signals: on-off keying (OOK) and amplitude shift keying (ASK)

3. FM produces multiple sideband frequencies above and below the carrier frequency. The bandwidth produced is a function of the highest modulating frequency including harmonics and the modulation index,

which is:m = Δf(T) where Δf is the frequency deviation or shift between the mark and space frequencies, or:$\Delta f = f_s - f_m$. T is the bit time interval of the data or the reciprocal of the data rate (1/bit/s).

4. Binary phase shift keying (BPSK), shifts the carrier sine wave 180° for each change in binary state. BPSK is coherent as the phase transitions occur at the zero crossing points.

5. Quadrature PSK (QPSK), the modulator produces two sine carriers 90° apart. The binary data modulates each phase, producing four unique sine signals shifted by 45° from one another

6. The maximum theoretical data rate or channel capacity (C) in bits/s is a function of the channel bandwidth (B) channel in Hz and the signal-to-noise ratio (SNR): $C = B\log_2 (1 + SNR)$

7.S/N = signal power/noise power. The noise power is the noise density N_o in watts/Hz times the transmitted signal bandwidth B_T in Hz:$S/N=S/(NoB_T)$

8.The signal energy in joules is the signal power in watts, S, times the bit period in seconds, which is 1/(data rate) = 1/R, thus $E=S(1/R)$.

9. QPSK or quadrature phase shift keying. It is produced by the circuit shown in Fig. 8.5. It takes the serial bitstream and passes it through a 2-bit shift register producing two parallel bitstreams at half the rate. One is called the in-phase (I) bitstream and the other the quadrature (Q) bitstream.

10. QPSK and QAM modulation methods are common in cable TV for digital TV as well as high-speed Internet service. They are also used with satellites and any broadband wireless application. All modern cell phones and most other digital wireless schemes use this type of modulation because of its spectral efficiency.

Short Questions (minimum 10 previous JNTUH Questions – Year to be mentioned

1. Draw the Signal space Diagram of ASK. [May 2016]

Signal Space Representation for ASK

- Clearly, there is one basis function of unit energy

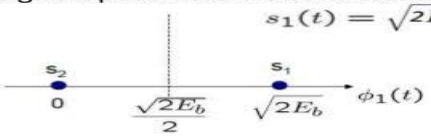
$$\phi_1(t) = \sqrt{\frac{2}{T_b}}\cos(2\pi f_c t) \qquad 0 \le t < T_b$$

- Then, $s_1(t) = \sqrt{E}\phi_1(t)$ $\qquad s_2(t) = 0$
- Average energy per bit

$$E_b = \frac{E+0}{2} \qquad \text{i.e. } E = 2E_b$$

- A binary ASK system is therefore characterized by having a signal space that is one-dimensional

$$s_1(t) = \sqrt{2E_b}\phi_1(t) \qquad s_2(t) = 0$$



$$d_{12} = \sqrt{2E_b}$$

2. List out the Advantages of Pass band Transmission over Baseband transmission [May 2016]

a. Long distance. b. Analog channels can be used for transmission. c. Multiplexing techniques can be used for bandwidth conservation. d. Transmission can be done by using wireless channel also.

3. Define QPSK. [Oct/Nov 2016]

QPSK is Quadriphase –shift keying. In QPSK the phase of the carrier takes on one of the four equally spaced values Such as π/4, 3π/4, 5π/4 and 7π/4. In QPSK two successive bits in the data sequence are grouped together. This combination of two bits forms four distinct symbols. When symbols are changed to next symbol the phase of the carrier is changed by 45^0

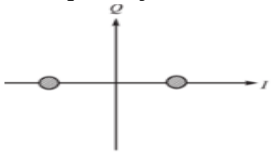
4. Write the expression for baud rate of BPSK system. [May 2017]

The baud rate of a data communications system is the number of symbols per second transferred. In BPSK each symbol represents one bit. Thus in BPSK the symbol or baud rate is equal to bit rate

5. Explain advantages of coherent digital modulation schemes. [May 2017]

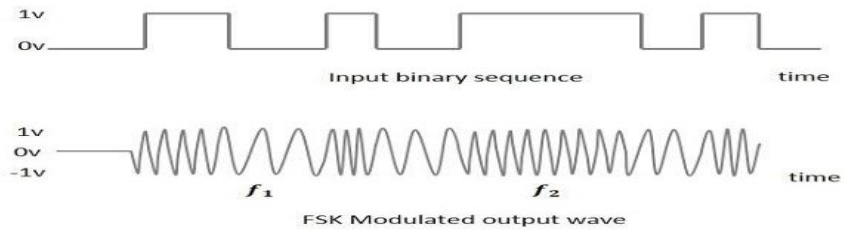
i.It improves receiver sensitivity.

ii.It Can extract amplitude, frequency, and phase information from a carrier, and consequently can achieve much higher capacity in the same bandwidth.



Constellation diagram of BPSK

6. **Sketch the wave form of the FSKsignal for the input binary sequence1100100010[May 2017]**



7. What is meant by DPSK? [Apr 2018]

The DPSK stands for "Differential phase-shift keying". It is one type of phase modulation used to transmit data by altering the carrier wave's phase. In this, the modulated signal's phase is moved e to the element of an previous signal. The phase of the signal tracks the low or high state of the previous element. This kind of phase-shift keying doesn't require a synchronous carrier on the demodulator.

8. Define ASK. [Apr 2018]

Amplitude-shift keying (ASK) is a form of amplitude modulation that represents digital data as variations in the amplitude of a carrier wave. In an ASK system, the binary symbol 1 is represented by transmitting a fixed-amplitude carrier wave and fixed frequency for a bit duration of T seconds.

9. Mention different types of digital modulation techniques [Dec 2018]

Three possible digital-to-analog modulation techniques are:

• Amplitude Shift Keying (ASK)
• Frequency Shift Keying (FSK)
• Phase Shift Keying (PSK)

10. Explain coherent detection [May 2019]

Coherent detection: In this method the local carrier generated at the receiver is phase locked with the carrier at the transmitter. Hence it is called synchronous detection

11. What is the difference between FSK and PSK [May 2019]

1. Phase-shift keying (PSK) is a digital modulation process which conveys data by changing (modulating) the phase of a constant frequency reference signal (the carrier wave). PSK uses a finite number of phases, each assigned a unique pattern of binary digits.
2. Frequency-shift keying (FSK) is a frequency modulation scheme in which digital information is transmitted through discrete frequency changes of a carrier signal. ... The simplest FSK is binary FSK (BFSK). BFSK uses a pair of discrete frequencies to transmit binary (0s and 1s) information.

12. Define the ISI [May 2019]

Intersymbol interference (ISI) is a form of distortion of a signal in which one symbol interferes with subsequent symbols. The presence of ISI in the system introduces errors in the decision device at the receiver output. Therefore, in the design of the transmitting and receiving filters, the objective is to minimize the effects of ISI, and thereby deliver the digital data to its destination with the smallest error rate. The effects of ISI are

shown in the second image which is an eye pattern of the same system when operating over a multipath channel.

Long Questions (minimum 10 previous JNTUH Questions – Year to be mentioned

1. With neat diagrams and equations, explain about PSK system.
b) Draw the space representation of BPSK. And also draw its waveforms? **[May 2016]**
2. The bit stream 1011100011 is to be transmitted using DPSK. Determine the encoded sequence and transmitted phase sequence.
b) Explain about DPSK system. And also give the comparison between DPSK and PSK. **[May 2016]**
3. Draw and explain the operating principle of ASK Modulator **[Dec 2018][May 2018]**
b) Describe the BPSK modulation technique with the help of a neat diagram. **[Oct/Nov 2016]**
4. Explain the DPSK modulation technique with the help of a neat sketch. **[Dec 2018]**
b) Explain the working of non-coherent FSK detector. . **[Oct/Nov 2016][May 2019]**
5. Draw and explain the working of optimum receiver with a neat diagram.
b) Define eye diagram. Draw the eye diagram for FSK. . **[Oct/Nov 2016]**
6. Explain frequency shift keying. Describe coherent detection of FSK signals. What should be the relationship between bit-rate and frequency-shift for a better performance**?** **[May 2017]**
b) Explain non coherent detection method of binary frequency shift keying scheme.
7. Explain coherent detection of PSK signals and derive probability of error**.** **[Dec 2018]**
b) Differentiate coherent and non-coherent detection techniques [**May 2017]**
8. Derive the bit error probability of a coherent ASK signaling scheme **[May 2017]**
9. Explain with neat diagram BFSK transmitter and receiver. **[May 2019]**
b) Give a comparison between FSK and PSK schemes**.** **[Apr 2018]**
10. Explain coherent ASK and non coherent ASK schemes.
b) Draw a diagram of DPSK transmitter.
11. Explain how the residual effects of the channel are responsible for ISI.
b) Explain about three tap reset equalizer. **[Apr 2018]**
12. Explain the process of FSK detection using PLL **[Dec 2018]**
13. Give a comparison between DPSK and PSK schemes**.** **[May 2019]**

Fill in the Blanks / Choose the Best: (Minimum 10 to 15 with Answers)

1. Average energy per bit is given by
a) average energy symbol/log2 M
b) average energy symbol * log2 M

c) log2 M/ Average energy symbol
d) none of the mentioned **[a]**

2. Which FSK has no phase discontinuity?
a) Continuous FSK
b) Discrete FSK
c) Uniform FSK
d) None of the mentioned **[a]**

3. FSK reception is
a) Phase Coherent
b) Phase non coherent
c) Phase Coherent & non coherent
d) None of the mentioned **[c]**

4. FSK reception uses
a) Correlation receiver
b) PLL
c) Correlation receiver & PLL
d) None of the mentioned **[c]**

5. In non coherent reception of FSK _____ is measured.
a) Phase
b) Energy
c) Power
d) None of the mentioned **[b]**

6. Simulation is used to determine
a) Bit error rate
b) Symbol error rate
c) Bit error
d) Symbol error **[a]**

7. Which is called as on-off keying?
a) Amplitude shift keying
b) Uni-polar PAM
c) Amplitude shift keying & Uni-polar PAM
d) None of the mentioned **[c]**

8. QAM uses _____ as the dimensions.
a) In phase
b) Quadrature
c) In phase & Quadrature
d) None of the mentioned **[c]**

9. Which has same probability of error?
a) BPSK and QPSK
b) BPSK and ASK
c) BPSK and PAM
d) BPSK and QAM **[c]**

10 Which system uses QAM?
a) Digital microwave relay
b) Dial up modem
c) Digital microwave relay & Dial up modem
d) None of the mentioned **[c]**

11.In _____the frequency of the carrier signal is varied based on the information of the signal [FSK]

12.In _____ the phase and amplitude of the carrier signal is varied based on the information of the digital signal [QAM]

13.Most modern modems use_____ for digital to analig modulation [QAM]

14._____ rate is the number of bits per second ._____rate is the number of signal units per second [Bit ,Baud]

15.If the bit rate is 2100bps and there are 4 bits for each signal element, then the baud rate is _____ [300]

16.The Baud rate is 1200 and there are 4 bits of each signal element, then the bit rate is _____ [400]

17.A 2-PSK modulated signal has a bit rate of 200bps, the baud rate is _____ [2000]

18.OOK is a type of _ modulation [ASK]

19.On a 16-QAM constellation diagram each constellation point reparesnts a _____ quadbit]

20.The number of points in the consellation of an 8-PSK modulation is _____ the number of points for an 8 QAM [equal to]