JEPPIAAR
ENGINEERING COLLEGE

JEPPIAAR NAGAR, CHENNAI – 600119

Department of Electronics & Communication Engineering

QUESTION BANK

EC3491–COMMUNICATION THEORY

II Year/IV Semester ECE

Regulation – 2021
(Batch: 2023 -2027)
Academic Year 2024 – 2025

JEPPIAAR ENGINEERING COLLEGE

Vision of the Institute	To build Jeppiaar Engineering College as an institution of academic excellence in technological and management education to become a world class University	
Mission of the Institute	**M1**	To excel in teaching and learning, research and innovation by promoting the principles of scientific analysis and creative thinking
	M2	To participate in the production, development and dissemination of knowledge and interact with national and international communities.
	M3	To equip students with values, ethics and life skills needed to enrich their lives and enable them to meaningfully contribute to the progress of society
	M4	To prepare students for higher studies and lifelong learning, enrich them with the practical and entrepreneurial skills necessary to excel as future professionals and contribute to Nation's economy

DEPARTMENT: ELECTRONICS AND COMMUNICATION ENGINEERING

Vision of the Department	To become a centre of excellence to provide quality education and produce creative engineers in the field of Electronics and Communication Engineering to excel at international level.	
Mission of the Department	**M1**	Inculcate creative thinking and zeal for research to excel in teaching-learning process
	M2	Create and disseminate technical knowledge in collaboration with industries
	M3	Provide ethical and value based education by promoting activities for the betterment of the society
	M4	Encourage higher studies, employability skills, entrepreneurship and research to produce efficient professionals thereby adding value to the nation's

		economy
PROGRAM OUTCOMES (PO)	PO 1	**Engineering knowledge**: **Apply** the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
	PO 2	**Problem analysis**: **Identify, formulate, review** research literature, and **analyze** complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
	PO 3	**Design/development of solutions**: **Design solutions** for complex engineering problems and **design** system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
	PO 4	**Conduct investigations of complex problems**: **Use** research-based knowledge and research methods including **design** of experiments, **analysis** and **interpretation** of data, and **synthesis** of the information to provide valid conclusions.
	PO 5	**Modern tool usage**: **Create**, **select**, and **apply** appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
	PO 6	**The engineer and society**: **Apply** reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
	PO 7	**Environment and sustainability**: **Understand** the impact of the professional engineering solutions in societal and environmental contexts, and **demonstrate** the knowledge of, and need for sustainable development.
	PO 8	**Ethics**: **Apply** ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
	PO 9	**Individual and team work**: **Function effectively** as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
	PO 10	**Communication**: **Communicate effectively** on complex engineering activities with the engineering community and with society at large, such as, being able **to comprehend** and **write** effective reports and **design** documentation, **make** effective presentations, and **give** and **receive** clear instructions.
	PO 11	**Project management and finance**: **Demonstrate** knowledge and understanding of the engineering and management principles and **apply** these to one's own work, as a member and leader in a team, to **manage** projects and in multidisciplinary environments.
	PO 12	**Life-long learning**: **Recognize** the need for, and have the preparation and ability to **engage** in independent and life-long learning in the broadest context of technological change.

PROGRAM EDUCATIONAL OBJECTIVES (PEOS)	**PEO I**	Produce technically competent graduates with a solid foundation in the field of Electronics and Communication Engineering with the ability to analyze, design, develop, and implement electronic systems.
	PEO II	Motivate the students for choosing the successful career choices in both public and private sectors by imparting professional development activities.
	PEO III	Inculcate the ethical values, effective communication skills and develop the ability to integrate engineering skills to broader social needs to the students.
	PEO IV	Impart professional competence, desire for lifelong learning and leadership skills in the field of Electronics and Communication Engineering.
PROGRAM SPECIFIC OUTCOMES (PSOs)	**PSO 1**	Design, develop and analyze electronic systems through application of relevant electronics, mathematics and engineering principles.
	PSO 2	Design, develop and analyze communication systems through application of fundamentals from communication principles, signal processing, and RF System Design & Electromagnetics.
	PSO 3	Adapt to emerging electronics and communication technologies and develop innovative solutions for existing and newer problems.

EC8491-COMMUNICATION THEORY
SYLLABUS

EC3491 COMMUNICATION SYSTEMS L T P C 3 0 0 3

COURSE OBJECTIVES:

- To introduce Analog Modulation Schemes
- To impart knowledge in random process
- To study various Digital techniques
- To introduce the importance of sampling & quantization
- To impart knowledge in demodulation techniques
- To enhance the class room teaching using smart connectivity instruments

UNIT I AMPLITUDE MODULATION 9

Review of signals and systems, Time and Frequency domain representation of signals, Principles of Amplitude Modulation Systems-DSB, SSB and VSB modulations. Angle Modulation, Representation of FM and PM signals, Spectral characteristics of angle modulated signals. SSB Generation – Filter and Phase Shift Methods, VSB Generation – Filter Method, Hilbert Transform, Pre-envelope & complex envelope AM techniques, Superheterodyne Receiver.

UNIT II RANDOM PROCESS & SAMPLING 9

Review of probability and random process. Gaussian and white noise characteristics, Noise in amplitude modulation systems, Noise in Frequency modulation systems. Pre-emphasis and De- emphasis, Threshold effect in angle modulation.

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

UNIT III DIGITAL TECHNIQUES 9

Pulse modulation Differential pulse code modulation. Delta modulation, Noise considerations in PCM,, Digital Multiplexers, Channel coding theorem - Linear Block codes - Hamming codes - Cyclic codes - Convolutional codes - Viterbi Decoder

UNIT IV DIGITAL MODULATION SCHEME 9

Geometric Representation of signals - Generation, detection, IQ representation, PSD & BER of Coherent BPSK, BFSK, & QPSK - QAM - Carrier Synchronization - Structure of Non-coherent Receivers Synchronization and Carrier Recovery for Digital modulation, Spectrum Analysis – Occupied bandwidth – Adjacent channel power, EVM, Principle of DPSK

UNIT V DEMODULATION TECHNIQUES 9

Elements of Detection Theory, Optimum detection of signals in noise, Coherent communication with waveforms- Probability of Error evaluations. Baseband Pulse Transmission- Inter symbol Interference, Optimum demodulation of digital signals over band-limited channels.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course students will be able to

CO1: Gain knowledge in amplitude modulation techniques
CO2: Understand the concepts of Random Process to the design of communication systems
CO3: Gain knowledge in digital techniques
CO4: Gain knowledge in sampling and quantization
CO5: Understand the importance of demodulation techniques

TEXTBOOKS :

1. Simon Haykins," Communication Systems", Wiley, 5th Edition, 2009.(Unit I - V)
2. B.P.Lathi, "Modern Digital and Analog Communication Systems", 4th Edition, Oxford University Press, 2011.

REFERENCES :

1. Wayner Tomasi, Electronic Communication System, 5th Edition, Pearson Education,2008.
2. D.Roody, J.Coolen, Electronic Communications, 4th edition PHI 2006
3. A.Papoulis, "Probability, Random variables and Stochastic Processes", McGraw Hill, 3rd edition, 1991.
4. B.Sklar, "Digital Communications Fundamentals and Applications", 2nd Edition Pearson Education 2007
5. H P Hsu, Schaum Outline Series - "Analog and Digital Communications" TMH 2006
6. Couch.L., "Modern Communication Systems", Pearson, 2001

UNIT-I
AMPLITUDE MODULATION

Review of signals and systems, Time and Frequency domain representation of signals, Principles of Amplitude Modulation Systems- DSB, SSB and VSB modulations. Angle Modulation, Representation of FM and PM signals, Spectral characteristics of angle modulated signals. SSB Generation – Filter and Phase Shift Methods, VSB Generation – Filter Method, Hilbert Transform, Pre-envelope & complex envelope AM techniques, Superheterodyne Receiver.

PART-A

1. **Define deterministic and random signals.**
   Deterministic signals can be exactly described by a mathematical expression. Random signals cannot be predicted and exhibit uncertainty.
2. **Classify signals based on time and value.**
   Signals are classified as continuous-time or discrete-time (based on time), and analog or digital (based on amplitude).
3. **What is the difference between continuous-time and discrete-time signals?**
   Continuous-time signals are defined at all time instances; discrete-time signals are defined at specific time intervals.
4. **State the properties of a linear time-invariant (LTI) system.**
   Linearity: satisfies superposition; Time-invariance: system behavior does not change over time.
5. **Distinguish between causal and non-causal systems.**
   Causal systems depend only on past and present inputs; non-causal systems depend on future inputs.
6. **What is meant by a time-invariant system?**
   A system is time-invariant if its output does not change when the input is shifted in time.
7. **Define Fourier Transform of a continuous-time signal.**
   The Fourier Transform expresses a time-domain signal as a sum of complex exponentials in the frequency domain.
8. **What is the significance of Fourier series in signal analysis?**
   It decomposes a periodic signal into a sum of sinusoids, aiding frequency domain analysis.
9. **State Parseval's theorem.**
   The total energy of a signal in the time domain equals the total energy in the frequency domain.
10. **What is the convolution integral?**
    It gives the output of an LTI system by integrating the product of the input and the time-shifted impulse response.
11. **Define bandwidth of a signal.**
    Bandwidth is the range of frequencies within which most of the signal's energy is concentrated.
12. **What is the relationship between time duration and spectral width of a signal?**
    They are inversely related: shorter time duration implies wider spectral width and vice versa.
13. **What is amplitude modulation?**
    It is the process of varying the amplitude of a carrier signal in proportion to the message signal.
14. **Define modulation index in AM.**
    Modulation index is the ratio of the peak message signal amplitude to the carrier amplitude.
15. **What is the bandwidth requirement for DSB-SC signals?**
    The required bandwidth is twice the highest frequency of the message signal, i.e., 2fm.
16. **Compare DSB-SC and SSB.**
    DSB-SC transmits both sidebands, SSB transmits only one sideband, reducing bandwidth and power.
17. **Define Single Sideband (SSB) modulation.**
    SSB is a type of AM where only one sideband (upper or lower) is transmitted to save bandwidth.
18. **What is Vestigial Sideband (VSB) modulation?**
    VSB transmits one full sideband and a part of the other. It is used in TV transmission.
19. **What is frequency modulation?**
    FM varies the instantaneous frequency of the carrier signal according to the message signal.

20. **Define modulation index in FM.**
    It is the ratio of frequency deviation to the frequency of the modulating signal.
21. **State the difference between narrowband and wideband FM.**
    Narrowband FM has small frequency deviation ($\beta < 1$); wideband FM has large deviation ($\beta > 1$).
22. **What is phase modulation?**
    Phase modulation changes the phase of the carrier signal in proportion to the message signal.
23. **How is FM signal bandwidth estimated using Carson's Rule?**
    Bandwidth = $2(\Delta f + fm)$, where Δf is frequency deviation and fm is the highest modulating frequency.
24. **Compare FM and AM based on bandwidth and noise immunity.**
    FM has better noise immunity but uses more bandwidth than AM.
25. **What is the filter method for SSB generation?**
    The modulated DSB signal is passed through a bandpass filter to remove one sideband.
26. **What is the phase shift method for SSB generation?**
    Two signals are generated with 90° phase shifts and combined to cancel one sideband.
27. **Explain the role of filters in VSB generation.**
    Filters are used to partially suppress one sideband and pass a vestige of it.
28. **Mention one application where VSB is preferred over AM and SSB.**
    VSB is used in TV video signal transmission due to its bandwidth efficiency.
29. **What is Hilbert Transform in communication systems?**
    It provides a phase shift of 90° to each frequency component and is used in SSB generation.
30. **Define pre-envelope and complex envelope of a signal.**
    Pre-envelope is the analytic signal with only positive frequencies; complex envelope is the baseband representation of a modulated signal.
31. **Why DSBFC-AM is bandwidth inefficient when compared with single sideband AM?**

    Single sideband, SSB modulation is basically a derivative of amplitude modulation, AM. Amplitude modulation is very inefficient from two points. The first is that it occupies twice the bandwidth of the maximum audio frequency, and the second is that it is inefficient in terms of the power used.
32. **Compare and contrast DSB-SC and SSB-SC with respect to i) power and ii) Bandwidth.**

DSB-SC	SSB-SC
Transmission Bandwidth $B_T = 2f_m$	Transmission Bandwidth $B_T = f_m$
Consumes less power than AM $P_T = P_{USB} + P_{LSB}$	Consumes less power than AM,DSB-SC , $P_T = P_{USB}$

33.What is VSB? Where is it used?

Vestigial sideband (VSB) is a type of amplitude modulation (AM) technique (sometimes called *VSB-AM*) that encodes data by varying the amplitude of a single carrier frequency . Portions of one of the redundant sidebands are removed to form a vestigial sideband signal - so-called because a vestige of the sideband remains.

The most prominent and standard application of VSB is for the transmission of **television signals**. Also, this is the most convenient and efficient technique when bandwidth usage is considered.

34. **Determine the Hilbert transform of cosωt.**
    The Hilbert transform of, cos $\omega_c t$ where $\omega > 0$, is cos ($\omega_c t$- 90).

If $x(t) = \cos\omega t$, then

$$H\{\cos\omega t\} = \upsilon(t)$$

$$= \frac{-1}{\pi} P\int_{-\infty}^{\infty} \frac{\cos\omega\eta}{\eta - t} d\eta$$

$$= \frac{-1}{\pi} P\int_{-\infty}^{\infty} \frac{\cos[\omega(y+t)]}{y} dy$$

$$= \frac{-1}{\pi} \left\{ \cos\omega t \, P\int_{-\infty}^{\infty} \frac{\cos\omega y}{y} dy - \sin\omega t \, P\int_{-\infty}^{\infty} \frac{\sin\omega y}{y} dy \right\}$$

$$= \sin\omega t.$$

35. What is pre envelope?

The **pre envelope** of a real signal $x(t)$ is the complex function $\boldsymbol{x_+(t) = x(t) + j\,\hat{x}(t)}$.
The pre envelope is useful in treating band pass signals and systems.

36. What is complex envelope?

The complex envelope of a band pass signal $x(t)$ is $\tilde{x}(t) = x(t)\, e^{-j2\pi f_c t}$

37. Suggest a modulation scheme for the broadcast video transmission and justify

VSB is preferred for TV transmission because of reduced bandwidth of modulation system and most of the required data present after modulation occupy the space near the carrier frequency Fc .

38. Define heterodyning

Heterodyning -To combine a radiofrequency wave with a locally generated wave of different frequency.
Inorder to produce a new frequency equal to the sum or difference of the two, also calledas frequency conversion, is used very widely in communications engineering to generate new frequencies and move information from one frequency channel to another.

39. What is the advantage of conventional DSB-AM over DSB-SC and SSB-SC AM

The receivers for conventional DSB-AM are simple and detection is easier.

40. A broadcast radio transmitter radiates 5 kW power when the modulation percentage is 60%. How much is the carrier power?

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

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

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

S.No	AM	DSB-SC	SSB-SC
1	Transmission Bandwidth $B_T = 2f_m$	Transmission Bandwidth $B_T = 2f_m$	Transmission Bandwidth $B_T = f_m$
2	Contains two sidebands	Contains two sidebands	Contains only one sideband
3	Consumes large power $P_T = P_C + P_{USB} + P_{LSB}$	Consumes less power than AM $P_T = P_{USB} + P_{LSB}$	Consumes less power than AM,DSB-SC , $P_T = P_{USB}$

42. . SSB is suitable for speech signals and not for video signals . why?

It is not possible to send one side band exactly eliminating the carrier and other side band. While rejecting the frequency components that are close to the carrier, the frequency components that are close to the carrier on the other sides are also adversely affected. This introduces distortion in the signal which is highly objectionable in the transmission of video signals.

43. Define modulation

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

44. .What is the need for modulation?

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

45. **. Define Modulation index and percent modulation for an AM wave.**

Modulation index is a term used to describe the amount of amplitude change present in an AM waveform .It is also called as coefficient of modulation.

Mathematically modulation index is
$\mathbf{m = E_m / E_c}$
Where m = Modulation coefficient
E_m = Peak change in the amplitude of the output waveform voltage.
E_c = Peak amplitude of the unmodulated carrier voltage.
Percent modulation (M) gives the percentage change in the amplitude of the output wave when the carrier is acted on by a modulating signal. It is modulation index multiplied by 100. **M = m * 100**

46. .Give the bandwidth of AM?

Bandwidth (B) of AM DSBFC is the difference between highest upper frequency and lowest lower side frequency.

$\mathbf{B = 2f_{m\,(max)}}$

$f_{m\,(max)}$ – maximum modulating signal frequency.

47. Give the formula for AM power distribution.

$$P_{total} = P_c\,[1 + m^2 / 2]$$

Where, P_{total} – total power m- Modulation index

48. Give the types of AM Modulation.

DSBSC-Double sideband suppressed carrier.
SSBSC- Single sideband suppressed carrier.
DSBFC - Double sideband full carrier.
VSBSC-Vestigial sideband suppressed carrier.

49. An amplitude modulation transmitter radiates 100 watts of unmodulated power. If the carrier is modulated power. If the carrier is modulated simultaneously by two tones of 40% and 60% respectively, calculate the total power radiated.

$$m_t = \sqrt{m_1^2 + m_2^2} = \sqrt{0.6^2 + 0.4^2} = 0.73$$

$$P_t = P_c\left(1 + \frac{m^2}{2}\right) = 127 \text{ watts}$$

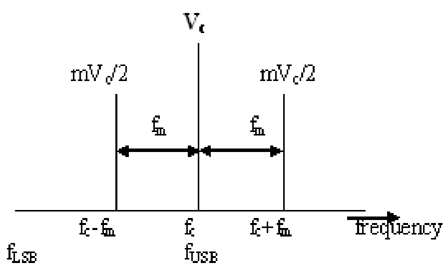
$P_c = un\bmod ulated\ carrierpower,\ p_t = total\ power, m = \bmod ulation index$

P_c – carrier power

50. **A transmitter radiates 9 KW without modulation and 10.125 KW after modulation. Determine depth of modulation**.

P_c=9kW, P_T=10.125 kW

51. Draw the spectrum of DSB-FC AM signal.



52. The antenna current of an AM transmitter is 8A when only carrier is sent. It increases to 8.93A when the carrier is modulated by a single sine wave. Find the percentage modulation.

Solution: Given: I_c =8A It=8.93A m=0.8

Formula: I_t=I_c (1+m2/2)^{½}

8.93=8(1+m2/2) ^{½}

m=0.701

I_t=8 (1+0.82/2)^{½}

I_t=9.1A

53. What is the relationship between total power in AM wave and unmodulated carrier power?

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

$P_c = un\bmod ulated\ carrier\ power,\ p_t = total\ power, m = \bmod ulation index$

54. What is the relationship between total current in AM wave and unmodulated carrier current?

$$I_t = I_c\sqrt{\left(1 + \frac{m^2}{2}\right)}$$

$I_t = total\ current, I_c = un\bmod ulated\ carrier\ cuurent, m = \bmod ulation\ index$

55. **For an AM system the instantaneous values of carrier & modulating signal are 60 sin ($2\pi f_c t$) & 40 sin($2\pi f_m t$),Determine the modulation index**?

$$m_a = \frac{E_m}{E_c} = \frac{40}{60} = 0.66$$

56. **A transmitter supplies 8 KW to the antenna when modulated. Determine the total, power radiated when modulated to 30%.**

m=0.3; Pc=8 kw

$P_t = P_c\,(1+m^2/2) = 8.36$ KW

57. **Compare various Amplitude Modulation systems.**

S.No	**Description**	**AM with carrier**	**DSB-SC AM**	**SSB-SC AM**	**VSB- AM**
1.	Bandwidth	2fm	2fm	fm	Fm < BW < 2fm
2.	Power saving	33.33%	66.6%	83%	75%
3.	Generation Method	Not difficult	Not difficult	difficult	difficult
4.	S/N Ratio	$(S/N)_o = 2/3(S/N)_i$	$(S/N)_o = 2(S/N)_i$	$(S/N)_o = (S/N)_i$	$(S/N)_o = (S/N)_i$
5.	Application	AM Broadcasting	Carrier Telephony	Wireless mobile	Television and high speed data transmission
6.	Side bands	2	2	1	1

58. **Distinguish between narrow band FM and wide band FM**

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

59. **What is the need of limiter circuits in FM systems**

FM receivers can be fitted with amplitude limiters to remove amplitude variations caused by noise.

60. **Define carrier swing.**

a. The total variation in frequency from the lowest to the highest is referred as carrier swing. The carrier swing is equal to twice the frequency deviation .Carrier swing = 2X frequency deviation.

61. **State the carson's rule**

b. used for bandwidth calculation of FM modulation,

c. **$BW=2(\Delta f + f_m)$,**

1. Δf = frequency deviation
2. f_m =modulating frequency

62. **Define modulation index, with reference to FM and PM**

Modulation index is the ratio of frequency deviation and modulating signal frequency.

$m = \frac{\Delta f}{f_m}$ Δf = frequency deviation (Hz), f_m = modulating signal frequency (Hz)

63. **A frequency modulated signal is given as S(t) = 20 cos [$2\pi f_c t + 4\sin 200\pi t$].Determine the required transmission bandwidth.**

1. $BW=2(\Delta f + f_m)$

3. $\Delta f = m_f * f_m = 4*200 = 800$
4. Therefore, BW = 2(800+ 200) = 2 KHz.

PART B&C

1. **Derive AM power distribution. Derive the AM wave equation and explain each term with the help of frequency spectrum. (or) Derive the modulated wave equation of an amplitude wave . obtain power relation also.**
2. **Discuss the detection process of DSB-SC and SSB-SC using coherent detector. Analyze the drawbacks of the suggested methology**
3. **i) Explain the operation of envelope detector**
   ii) Discuss the generation of single sideband modulated signal.
4. **Explain with block diagram the superheterodyne Receiver**
5. **5.Derive an expression for output voltage of a balanced modulator to generate DSB-SC and explain its working principle.**

6.Explain the Hilbert transform with an example

7.Discuss the properties of Hilbert Transform

8.Discuss the generation of single sideband modulated signal.

9.Discuss the process of recovering single sideband modulated signal.

10.Derive the output expression for an AM DSBFC and also draw the AM spectrum

11.Explain with suitable diagrams the generation of AM using square law method. Derive its efficiency.

12.Draw an envelope detector circuit used for demodulation of AM and explain its operation

13.Derive the expression for DSB-SC AM and calculate its power & efficiency. Explain a method to generate and detect it.

14.Explain in detail vestigial sideband modulation (VSB) generation and also mention the role of VSB in commercial TV broadcasting.

15.Discuss the principle of Ring Modulator with its applications

16. Explain the Filter and Phase shift method of generating SSB wave.

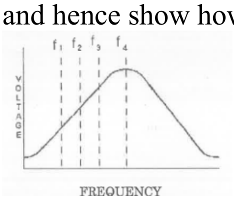
17.Explain the concept of pre envelope and complex envelope with block diagram.

18. Derive the expression for frequency and phase modulated signal.

19. Let m(t) = cos $4\pi*10^3)t$ be the message signal and c(t)=5cos|2 π $*10^6)t]$ be the carrier signal. c(t) and m(t) are used to generate an FM signal. If the peak frequency deviation of the generated FM signal is three times the transmission bandwidth of the AM signal. Then, calculate the coefficient of the term cos 4 π $(1006*10^3)t]$ in the FM signal in terms of the Bessel coefficients.

20. Draw and explain the working of a square law modulator and square law detector.
A DSB-SC signal is to be generated with a carrier frequency fc=1 MHz using a non-linear device with input-output relation given by V. $=aV+bV^3$, where a and b are constants. The output of the non-linear device is filtered by a band pass filter. Let the V=Ac' cos (2π ft) + m(t), where m(t) is the message signal. Then, calculate the value of f_C

21. Identify the detector with the frequency response shown in Figure 1. Assuming an FM signal s(t) with carrier frequency fc = f2 Hz and bandwidth BT = (fs - fi) Hz is given as input to the detector. Derive the output of the detector and hence show how the FM signal is demodulated.



22. Derive the mathematical expressions for DSB-SC and SSB-SC modulated signals.

23. Explain the filtering scheme used for the generation of VSB modulated wave and show how VSB modulation is applied in commercial TV broadcasting. Also discuss about the waveform distortion caused by an envelope detector that is used to demodulate the video in VSB modulated signal.

24.(i) State and illustrate Hilbert transform. (3)
(ii) State and prove any three properties of Hilbert transform. (6)
(iii) Find the Hilbert transform of the function $g(t)=m(t)\sin(2\pi f_c t)$,
given that $m(t)\leftrightarrow M(f)$. (4)

25.Calculate the Hilbert Transform of the function, $f(t) = \cos(w_1 t) + \sin(w_2 t)$.

UNIT II
RANDOM PROCESS & SAMPLING

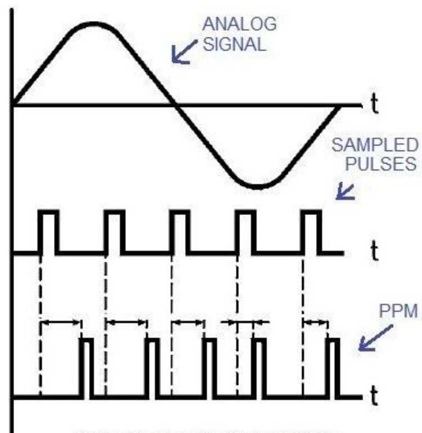
Review of probability and random process. Gaussian and white noise characteristics, Noise in amplitude modulation systems, Noise in Frequency modulation systems. Pre-emphasis and De- emphasis, Threshold effect in angle modulation. Low pass sampling – Aliasing- Signal Reconstruction-Quantization - Uniform & non-uniform quantization - quantization noise - Nyquist criterion- Logarithmic Companding –PAM, PPM, PWM, PCM – TDM, FDM

PART-A

1. Define random variable.
   A random variable is a function that maps outcomes of a random experiment to real numbers.
2. What is a probability density function (PDF)?
   A PDF gives the likelihood of a continuous random variable taking on a particular value.
3. State any two properties of a PDF.
   The PDF is non-negative, and its integral over the entire range is 1.
4. Define autocorrelation function.
   It is the expected value of the product of a signal with a time-shifted version of itself.
5. What is a stationary random process?
   A process whose statistical properties do not change with time.
6. Define ergodic process.
   A process where time averages equal ensemble averages.
7. What is Gaussian noise?
   Gaussian noise has amplitude values that follow a Gaussian (normal) distribution.
8. What is white noise?
   White noise has a constant power spectral density over all frequencies.
9. State two properties of Gaussian noise.
   It is completely described by its mean and variance, and it has a bell-shaped PDF.
10. What is the power spectral density of white noise?
    It is constant over all frequencies.
11. How does noise affect AM systems?
    In AM, both the carrier and sidebands are affected by noise, degrading signal quality.
12. Why is FM more resistant to noise than AM?
    FM is less affected by amplitude noise due to constant amplitude transmission.
13. What is the threshold effect in FM?
    It is a sharp decline in FM signal quality when the SNR falls below a certain level.
14. What is pre-emphasis?
    It is the boosting of high-frequency components before modulation.
15. What is de-emphasis?
    It is the attenuation of high frequencies after demodulation to restore original signal.
16. State Nyquist sampling theorem.
    The sampling rate must be at least twice the maximum frequency of the signal to avoid aliasing.
17. What is aliasing?
    It is the overlapping of frequency components when a signal is undersampled.
18. What is low-pass sampling?
    Sampling a baseband signal using a sampling frequency greater than twice its bandwidth.
19. How can aliasing be prevented?
    By using an anti-aliasing filter and sampling above the Nyquist rate.
20. Define signal reconstruction.
    It is the process of recovering a continuous signal from its sampled version.
21. What is quantization?
    Quantization is the process of mapping a range of input values to discrete output levels.
22. Differentiate uniform and non-uniform quantization.
    Uniform uses equal step sizes; non-uniform uses varying step sizes based on signal properties.
23. What is quantization noise?
    It is the error between the actual analog value and its quantized digital value.

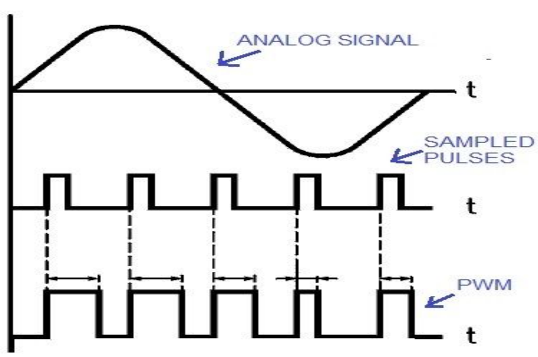
24. What is the purpose of companding?
    To reduce quantization noise in signals with wide dynamic range.
25. What is logarithmic companding?
    A process where the dynamic range is compressed logarithmically before quantization and expanded after decoding.
26. What is PAM?
    Pulse Amplitude Modulation represents the signal by varying the amplitude of the pulses.
27. What is PPM?
    Pulse Position Modulation encodes the message by varying the position of each pulse.
28. What is PWM?
    Pulse Width Modulation varies the width of each pulse according to the amplitude of the message signal.
29. What is PCM?
    Pulse Code Modulation involves sampling, quantizing, and digitally encoding an analog signal.
30. Differentiate TDM and FDM.
    TDM shares time slots among signals; FDM assigns separate frequency bands.

31.Give the graphical representation of PPM



Pulse Position Modulation (PPM)

32. Give the graphical representation of PWM.



33.Mention the advantages of PWM. Noise interference is less or minimum.
System is moderate in complexity to implement.
It has moderate power efficiency among all three types.
It supports higher power handling capability.

34.**.Mention the Disadvantages of PWM.**
Instantaneous power of transmitter varies.
The system requires semiconductor devices with low turn-ON and turn-OFF times. Hence they are very expensive.
High switching losses due to higher PWM frequency.

PART B&C

1. **Explain the characteristics of Gaussian and white noise. Derive the expression for power spectral density of white noise.**
2. **Describe the effect of noise in amplitude modulation systems and frequency modulation systems. Compare their noise performance.**
3. **Discuss in detail the concept of pre-emphasis and de-emphasis in FM systems. Explain their importance with suitable diagrams.**
4. **What is threshold effect in angle modulation? How does it affect FM system performance at low signal-to-noise ratios?**
5. **Explain the concept of sampling. Derive and explain the Nyquist sampling theorem. What is aliasing and how can it be avoided?**
6. **Describe the process of signal reconstruction from its samples. Explain ideal and practical reconstruction techniques.**
7. **Differentiate between uniform and non-uniform quantization. Explain quantization noise and discuss how it affects signal quality.**
8. **Explain logarithmic companding. Describe μ-law and A-law companding techniques used in digital communication.**
9. **Write short notes on PAM, PPM, PWM, and PCM. Compare their bandwidth and noise performance.**
10. **Explain the principles of Time Division Multiplexing (TDM) and Frequency Division Multiplexing (FDM). Compare their advantages and applications.**
11. Ten sinusoidal message signals, each bandlimited to 5 kHz, are multiplexed using TDM. The sampling rate is chosen 50% more than the Nyquist rate. The maximum quantization error should be at most 2% of the peak amplitude of the message signal. The number of synchronization bits is considered to be 5. Determine the transmission bit rate for the given system.
12. A message signal of 10 cos $(4\Pi * 10^3)$] is transmitted through PCM system. If sampling frequency equal to twice the Nyquist rate, and signal to quantization noise ratio (SQNR) should be minimum of 22 dB, then find the transmission bandwidth and SQNR in dB.
13. If the analog signal to be quantized (unipolar quantization with 4 bits) has a range from 0 V to 10 V, determine number of quantization level, quantization step (resolution), quantization error when the analog input is 7.4 V, quantization level when the analog voltage is 7.4 V, and its binary code.
14. Calculate the Nyquist sampling rate for the signal given below:x(t)=sin (100Π t). sin c (200t)/πt
15. Consider the signal x(t)=e/20+e/30, where 't' is in seconds. A new signal y(t)= x(2t+6) is formed. Find out the Nyquist sampling rate of y(t).

UNIT III
DIGITAL TECHNIQUE

Pulse modulation Differential pulse code modulation. Delta modulation, Noise considerations in PCM,, Digital Multiplexers, Channel coding theorem - Linear Block codes - Hamming codes - Cyclic codes - Convolutional codes - Viterbi Decoder

PART-A

1. **What is pulse modulation?**
   Pulse modulation is the process of modulating a message signal using a train of pulses, by varying parameters like amplitude, width, or position.
2. **What is Pulse Code Modulation (PCM)?**
   PCM is a digital pulse modulation technique where an analog signal is sampled, quantized, and encoded into binary form.
3. **What is Differential Pulse Code Modulation (DPCM)?**
   DPCM encodes the difference between the current and previous sample values, reducing redundancy.
4. **Mention one advantage of DPCM over PCM.**
   DPCM requires fewer bits per sample, reducing bandwidth requirements.
5. **Define Delta Modulation (DM).**
   Delta modulation is a one-bit version of DPCM that encodes only the direction of change from the previous sample.
6. **What is slope overload in delta modulation?**
   Slope overload occurs when the rate of change of the input signal is too high for the modulator to track.
7. **What is granular noise in delta modulation?**
   Granular noise occurs when the step size is too large, causing small signal changes to be poorly represented.
8. **How is adaptive delta modulation different from delta modulation?**
   Adaptive delta modulation adjusts the step size dynamically based on the signal's characteristics.
9. **Mention one noise consideration in PCM systems.**
   Quantization noise is a primary source of distortion in PCM systems.
10. **What is quantization noise?**
    It is the error between the actual analog value and its quantized digital representation.
11. **Why is PCM less susceptible to noise?**
    Because PCM uses digital signals, it can be regenerated and is immune to cumulative noise and distortion.
12. **What is a digital multiplexer?**
    A digital multiplexer combines multiple digital input signals into a single transmission line based on control signals.
13. **What is Time Division Multiplexing (TDM)?**
    TDM transmits multiple signals over a single channel by assigning them different time slots.
14. **Define the channel coding theorem.**
    It states that reliable communication is possible if the transmission rate is below the channel capacity.
15. **What is the significance of the channel capacity?**
    It is the maximum rate at which data can be transmitted over a channel with arbitrarily low error probability.
16. **What is linear block coding?**
    A method of error control where k input bits are encoded into n-bit codewords using linear operations.
17. **What is the purpose of block codes?**
    To detect and correct errors introduced during transmission.
18. **Define Hamming distance.**
    It is the number of bit positions in which two codewords differ.
19. **How many errors can a code with minimum Hamming distance dmind_{min} detect?**
    It can detect up to dmin−1d_{min} - 1 errors.
20. **What is a Hamming code?**
    A linear error-correcting code that can detect two-bit errors and correct single-bit errors.
21. **Give the formula for the number of parity bits in Hamming code.**
    For kk data bits and rr parity bits: 2r≥k+r+12^r \geq k + r + 1.
22. **What is a cyclic code?**
    A type of block code where cyclic shifts of codewords result in another valid codeword.

23. **What is the generator polynomial in cyclic codes?**
    A polynomial used to generate cyclic codewords by dividing the message polynomial.
24. **Mention one property of cyclic codes.**
    They are linear and possess cyclic invariance.
25. **What are convolutional codes?**
    Codes generated by passing the input sequence through a linear finite-state shift register.
26. **What is constraint length in convolutional codes?**
    It refers to the number of memory elements in the encoder; it determines how many input bits affect the output.
27. **What is a code rate in convolutional coding?**
    The ratio k/nk/n, where kk is the number of input bits and nn is the number of output bits per step.
28. **What is the purpose of the Viterbi decoder?**
    To decode convolutional codes by finding the most likely transmitted sequence.
29. **Why is the Viterbi algorithm optimal?**
    It minimizes the probability of error using maximum likelihood decoding.
30. **State one application of convolutional coding.**
    Used in mobile communication, satellite systems, and deep space telemetry.

PART B

1. **Explain the principle of Pulse Amplitude Modulation (PAM). Compare it with PPM and PWM in terms of waveform, bandwidth, and noise immunity.**
2. **Describe the working of Differential Pulse Code Modulation (DPCM) with a neat block diagram. Mention its advantages over PCM.**
3. **What is Delta Modulation (DM)? Explain the operation of delta modulator and demodulator with diagrams and mention the advantages and limitations.**
4. **Compare PCM, DPCM, and Delta Modulation based on bandwidth requirement, complexity, and signal quality.**
5. **Discuss the noise considerations in PCM systems. Explain how quantization noise affects the performance of PCM.**
6. **Explain the structure and function of a digital multiplexer. How is TDM implemented in digital communication systems?**
7. **State and explain the Channel Coding Theorem. How does it relate to reliable communication over noisy channels?**
8. **What are Linear Block Codes? Explain the encoding and decoding process with a suitable example.**
9. **Explain Hamming codes. Derive the minimum number of redundant bits required for error detection and correction.**
10. **What is meant by the minimum Hamming distance? How does it relate to the error-correcting capability of a code?**
11. **Explain the concept of Cyclic Redundancy Check (CRC). How is it implemented in communication systems?**
12. **Describe the encoding process of Cyclic Codes with the help of generator polynomial. Give a suitable example.**
13. **Explain the structure and working of Convolutional Codes. Use a trellis diagram to illustrate the encoding of a message sequence.**
14. **What is the Viterbi decoding algorithm? Explain how it is used for decoding convolutional codes with an example.**
15. **Compare Linear Block Codes, Cyclic Codes, and Convolutional Codes in terms of structure, error detection/correction capability, and complexity.**
16. Explain in detail slope overload and granular error in delta modulation and how these errors can be reduced.
17. Derive the expressions for quantization noise, receiver noise and overall signal-to-noise ratio of a DM system.
18. For (n=7, k = 4) linear block code (LBC) with the following generator Matrix

$$G = \left(\begin{array}{ccc|cccc} 1 & 0 & 1 & 1 & 0 & 0 & 0 \\ 1 & 1 & 0 & 0 & 1 & 0 & 0 \\ 0 & 1 & 1 & 0 & 0 & 1 & 0 \\ 1 & 1 & 1 & 0 & 0 & 0 & 1 \end{array}\right)$$

Construct the code book and find the value of the minimum hamming distance dmin (3)

Calculate the error correction and error detection capabilities of this code.

Construct the parity check matrix for the above code.

Decode the received message r=(0;0;1;1;0;1;0) using syndrome decoding.

19. Consider the (n=7, k=4) cyclic code defined by the generator polynomial g(x)=1+x2+x3.

(i)Develop the encoder.(3)

(ii) Determine its generator matrix C and parity-check matrix H. (3)

(iii) Determine the systematic code word of the message sequence (1100). (3)

(iv) Suppose a code word is sent over a noisy channel with the received word as 1001001. What would be the error polynomial e(x)? (4)

20.Explain the operation of a cyclic code (7,3) with a suitable generator polynomial.

UNIT IV
DIGITAL MODULATION SCHEME

Geometric Representation of signals - Generation, detection, IQ representation, PSD & BER of Coherent BPSK, BFSK, & QPSK - QAM - Carrier Synchronization - Structure of Non-coherent Receivers Synchronization and Carrier Recovery for Digital modulation, Spectrum Analysis – Occupied bandwidth – Adjacent channel power, EVM, Principle of DPSK

PART-A

1. **Define basis function in signal space representation.**
   A basis function is a set of orthonormal functions used to represent signals in geometric (vector) space.
2. **What is signal constellation?**
   Signal constellation is a diagram that represents symbol points as vectors in I-Q (in-phase and quadrature) space.
3. **Represent BPSK geometrically in signal space.**
   BPSK has two points on the real axis: $+\sqrt{E}$ and $-\sqrt{E}$, where E is the energy per bit.
4. **How is Euclidean distance used in signal detection?**
   Euclidean distance measures the closeness between received and possible transmitted signals to minimize error.
5. **Differentiate between orthogonal and non-orthogonal signal representation.**
   Orthogonal signals have zero cross-correlation; non-orthogonal signals do not, causing possible interference.
6. **Describe the generation of BPSK signal.**
   BPSK is generated by multiplying the carrier with ±1 depending on the binary data (0 or 1).
7. **How is BFSK signal detected coherently?**
   BFSK uses two coherent detectors tuned to each frequency and chooses the stronger output.
8. **What is the main difference between coherent and non-coherent detection?**
   Coherent detection requires carrier phase information; non-coherent does not.
9. **State the method used for generating QPSK.**
   QPSK is generated by splitting the bitstream into I and Q channels and modulating them with carriers 90° out of phase.
10. **Draw the block diagram of coherent QPSK detection.**
    Involves a demodulator with mixers, LPFs, and decision devices using I and Q carriers in-phase and quadrature.

11. **Define I and Q components of a modulated signal.**
    I (in-phase) and Q (quadrature) are projections of a signal onto cosine and sine carriers, respectively.
12. **Write the IQ representation of a QAM signal.**
    s(t)=I(t)cos(2πfct)−Q(t)sin(2πfct)
13. **What are the advantages of IQ representation in digital modulation?**
    It simplifies complex modulation schemes and enables easier implementation in DSP systems.
14. **How does IQ representation help in software-defined radios?**
    It allows flexible and reconfigurable modulation/demodulation using software algorithms.
15. **What is the role of mixers in I/Q signal generation?**
    Mixers modulate the I and Q signals with cosine and sine carriers to generate complex modulated waveforms.
16. **Sketch and label the PSD of a BPSK signal.**
    It is a sinc² shape centered at the carrier with bandwidth 2Rb2R_b2Rb, where RbR_bRb is bit rate.
17. **Compare the BER performance of BPSK and BFSK.**
    In AWGN, coherent BPSK has better BER performance than coherent BFSK for the same energy per bit.
18. **State the expression for BER of coherent BPSK in AWGN.**

$$P_b = Q\left(\sqrt{\frac{2E_b}{N_0}}\right)$$

19. **Why does QPSK have better spectral efficiency than BPSK?**
    QPSK transmits 2 bits per symbol compared to 1 bit in BPSK, doubling spectral efficiency.
20. **What is the effect of noise on the PSD of digital signals?**
    Noise flattens the spectrum, raising the noise floor and possibly causing interference across frequencies.
21. **Define 16-QAM. How many bits are carried per symbol?**
    16-QAM transmits 4 bits per symbol (since log[illegible]2(16)=4\log_2(16) = 4log2(16)=4).

22. **Compare QAM and PSK in terms of bandwidth efficiency.**
    QAM offers better bandwidth efficiency by combining amplitude and phase variations to encode more bits per symbol.
23. **Represent 8-QAM constellation.**
    It includes 8 points arranged asymmetrically in the I-Q plane, varying both amplitude and phase.
24. **What is carrier synchronization?**
    Carrier synchronization is the process of aligning the receiver's oscillator frequency and phase with the transmitter.
25. **List methods for carrier synchronization.**
    Costas Loop, Phase-Locked Loop (PLL), and Decision-Directed Loop.
26. **What is a non-coherent receiver?**
    A non-coherent receiver detects signals without needing exact carrier phase information.
27. **Give the structure of a non-coherent BFSK receiver.**
    It has two bandpass filters followed by envelope detectors and a decision logic unit.
28. **Define carrier recovery.**
    Carrier recovery is the extraction of the original carrier phase/frequency from the received signal for demodulation.
29. **Define Occupied Bandwidth.**
    It is the bandwidth that contains 99% of the total signal power.
30. **What is Error Vector Magnitude (EVM)?**
    EVM measures the deviation of received symbol vectors from ideal symbol positions in the I-Q plane.

PART- B

1. Explain the geometric representation of digital signals using signal space concepts. Illustrate with examples of BPSK and QPSK.
2. With a neat block diagram, explain the generation and coherent detection of a BPSK signal. Derive its error probability in AWGN channel.
3. Compare the coherent and non-coherent detection techniques for BFSK. Derive expressions for their bit error probabilities.
4. Explain the transmitter and receiver structure of QPSK. Illustrate with constellation diagrams and waveform examples.
5. What is IQ modulation? Explain how complex baseband signals are represented and used for digital modulation schemes such as QAM and QPSK.
6. Derive the power spectral density of BPSK and QPSK signals. Compare their bandwidth requirements and spectral efficiency.
7. Derive and compare the bit error rate (BER) expressions for coherent BPSK, BFSK, and QPSK under AWGN conditions. Use appropriate graphs to illustrate.
8. Explain the principle of QAM. Derive its bandwidth efficiency and BER expression. Compare 16-QAM and 64-QAM in terms of performance.
9. Discuss the need for carrier synchronization in digital receivers. Explain different techniques used for carrier recovery.
10. With a diagram, explain the operation of a Costas loop used for carrier phase recovery in coherent demodulators.
11. Describe the structure and working of a non-coherent receiver for BFSK or DPSK. Highlight advantages and limitations.
12. Explain the role of symbol synchronization in digital communication systems. Describe methods used for symbol timing recovery.
13. Define and explain the significance of the following in spectrum analysis:
    (a) Occupied bandwidth
    (b) Adjacent Channel Power
    (c) Error Vector Magnitude (EVM)
14. Explain the principle of DPSK. How does it eliminate the need for carrier phase synchronization? Derive the BER for non-coherent DPSK.
15. Compare BPSK and DPSK in terms of implementation, complexity, and error performance. Support your answer with signal diagrams.

16. What is difference between M-ary QAM and M-ary PSK? Explain it using constellation diagram for different values of M = 2, 4 and 16.
17. Explain the detail about QAM with a neat sketch and show the signal constellation diagram for 16-QAM.

(ii) QAM typically consists of two-Dimensional PAM. Under AWGN channel of zero mean and 2 side PSD N,/2, find the following by assuming symbol period as 7'.

(1) Signal constellation of 16-QAM (4-PAM in I and 4-PAM in Q channel) with minimum energy.
(2) Average symbol rate in terms of E,/.N, (ratio of energy per symbol and noise).
(3) Design modulator and demodulator.

UNIT V
DEMODULATION TECHNIQUES

Elements of Detection Theory, Optimum detection of signals in noise, Coherent communication with waveforms-Probability of Error evaluations. Baseband Pulse Transmission- Inter symbol Interference, Optimum demodulation of digital signals over band-limited channels.

PART-A

1. Define Hypothesis testing in detection theory.
   It is the process of deciding between two or more hypotheses based on observed data.
2. What is a likelihood ratio?
   The likelihood ratio is the ratio $\Lambda(x)=p(x|H1)/p(x|H0)$ used for making optimal decisions.
3. What does MAP detection stand for?
   Maximum A Posteriori detection chooses the hypothesis with the highest posterior probability.
4. What is ML detection?
   Maximum Likelihood detection chooses the hypothesis that maximizes the likelihood function $p(x|Hi)$
5. What is the Neyman-Pearson criterion?
   A method to maximize detection probability for a given false alarm probability.
6. Define false alarm and miss probability.
   False alarm: deciding H1 when H0 is true; Miss: deciding H0 when H1 is true.
7. What is the matched filter?
   A filter that maximizes the signal-to-noise ratio (SNR) for known signals in white Gaussian noise.
7. Define signal space representation.
   It represents signals as vectors in an orthonormal basis, simplifying detection.
8. What is the optimum detector in AWGN?
   The correlator or matched filter followed by a threshold decision rule.
9. What is energy detection?
   A non-coherent method where decision is based on the received signal's energy.
10. Give the formula for SNR at matched filter output.
    SNR=Es/N0, where Es is signal energy and N_0 is noise PSD.
11. State the purpose of whitening filter.
    It converts colored noise to white noise to enable matched filtering.
13. What is coherent detection?
    Detection where the receiver has exact phase reference of the carrier signal.
14. Define BER.
    Bit Error Rate is the probability that a bit is incorrectly detected.
15. What is the main advantage of coherent detection?
    It offers lower error probability compared to non-coherent detection.
16. Give an example of coherent modulation.
    Binary Phase Shift Keying (BPSK).
17. What determines the decision boundary in signal space?
    The minimum Euclidean distance rule between signal points.
18. What is the Euclidean distance in signal detection?
    It is the norm $\|s1-s2\|$ used to compare signal vectors.
19. Give the BER formula for BPSK in AWGN.
    Pe=Q(2Eb/N0))
20. What is the Q-function?

$$Q(x) = \frac{1}{\sqrt{2\pi}} \int_x^{\infty} e^{-t^2/2} dt$$

21. How does increasing Eb/N0E_b/N_0Eb/N0 affect BER?
    It decreases BER, improving reliability.
22. What is union bound in error probability?
    An upper bound on error probability using pairwise distances.

23. State the BER for QPSK in AWGN.
    $P_e = Q\left(\sqrt{\frac{2E_b}{N_0}}\right)$ same as BPSK.
24. What is ISI?
    Intersymbol Interference is when past symbols affect the current symbol, causing distortion.
25. State the Nyquist criterion for zero ISI.
    The impulse response must satisfy $h(nT) = \delta_n$ at sampling instants.
26. What causes ISI?
    Band-limiting of channel or pulse shaping filters.
27. What is a raised cosine filter used for?
    To satisfy Nyquist criterion and control ISI.
28. How does channel bandwidth affect ISI?
    Limited bandwidth increases ISI.
29. What is the role of equalizer in digital communication?
    To compensate for ISI introduced by the band-limited channel.
30. What is a decision-feedback equalizer (DFE)?
    It uses previously detected symbols to subtract ISI and improve detection.

PART-B

1. Define the Neyman-Pearson criterion. How is it applied in signal detection?
2. Differentiate between matched filter and correlator receiver in optimum signal detection.
3. Derive the expression for the probability of error for binary hypothesis testing in AWGN.
4. What is Maximum Likelihood (ML) detection? How is it different from MAP detection?
5. Explain the concept of signal space representation and its relevance in detection theory.
6. What is coherent detection? How does it differ from non-coherent detection?
7. Evaluate the probability of error for coherent BPSK over an AWGN channel.
8. Discuss the role of orthogonality in reducing inter-symbol interference in digital communication.
9. Describe the Q-function and its significance in error probability evaluation.
10. Compare the error performance of BPSK, QPSK, and FSK under coherent detection.
11. What is Inter-Symbol Interference (ISI)? What are its causes in baseband transmission?
12. Explain the Nyquist Criterion for zero ISI and derive its condition.
13. Describe raised cosine filtering and its role in mitigating ISI.
14. Differentiate between linear and decision-feedback equalizers. How do they combat ISI?
15. Explain optimum demodulation in the presence of ISI over a band-limited channel. What role does the Viterbi algorithm play?
16. Explain in detail about Channel Equalizer by focusing more on zero forcing equalizer (ZFE) and minimum mean-square error equalizer (MMSEE) with necessary figures, block diagrams and mathematical expressions.
17. What is matched filter receiver? Derive the expression for impulse response of a matched filter receiver
18. Illustrate and elaborate the following concepts with mathematical expressions.
    (i) Receiver Noise. (4)
    (ii) Probability of False Alarm. (4)
    (iii) The Matched Filter. (5)
19. What is Intersymbol Interference (ISI)? What are the ways to reduce ISI? Discuss in detail
    A source is transmitting 2 possible symbols of binary 1 and 0. When symbol 1 is transmitted, the signal voltage at the input of the threshold comparator can take any value between 0 volts and 1 volt with equal probability. When symbol 0 is transmitted, the signal voltage varies between —0.25 volts and 0.25 volts with equal probability. Determine the average probability of error, assuming a threshold Voltage of 0.2 volts.
20. Discuss the different modulation schemes in digital communication and derive the probability of error for any bandwidth efficient modulation technique.