JEPPIAAR ENGINEERING COLLEGE

Department of Electronics & Communication Engineering

QUESTION BANK

EC3501 – WIRELESS COMMUNICATION

V Semester ECE

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.

EC3501 WIRELESS COMMUNICATION L T P C
3 0 2 4

COURSE OBJECTIVES:

- To study and understand the concepts and design of a Cellular System.
- To Study And Understand Mobile Radio Propagation And Various Digital Modulation Techniques.
- To Understand The Concepts Of Multiple Access Techniques And Wireless Networks

UNIT-I THE CELLULAR CONCEPT-SYSTEM DESIGN FUNDAMENTALS 9

Introduction-Frequency Reuse-Channel Assignment Strategies-**Handoff Strategies**: Prioritizing Handoffs, Practical Handoff Considerations. **Interference And System Capacity**: Co-Channel Interference And System Capacity-Channel Planning For Wireless Systems, Adjacent Channel Interference, Power Control For Reducing Interference, Trunking And Grade Of Service. **Improving Coverage And Capacity In Cellular Systems**: Cell Splitting, Sectoring.

UNIT-II MOBILE RADIO PROPAGATION 9

Large Scale Path Loss: Introduction To Radio Wave Propagation - Free Space Propagation Model – **Three Basic Propagation Mechanism**: Reflection – Brewster Angle- Diffraction Scattering. **Small Scale Fading And Multipath**: Small Scale Multipath Propagation, Factors Influencing Small-Scale Fading, Doppler Shift, Coherence Bandwidth, Doppler Spread And Coherence Time. **Types Of Small-Scale Fading**: Fading Effects Due To Multipath Time Delay Spread, Fading Effects Due To Doppler Spread.

UNIT- III MODULATION TECHNIQUES AND EQUALIZATION AND DIVERSITY 9

Digital Modulation – An Overview: Factors That Influence The Choice Of Digital Modulation, **Linear Modulation Techniques**: Minimum Shift Keying (MSK), Gaussian Minimum Shift Keying(GMSK), **Spread Spectrum Modulation Techniques**: Pseudo- Noise (PN) Sequences, Direct Sequence Spread Spectrum (DS-SS)- Modulation Performance In Fading And Multipath Channels- **Equalization, Diversity And Channel Coding**: Introduction-Fundamentals Of Equalization- **Diversity Techniques**: Practical Space Diversity Considerations, Polarization Diversity, Frequency Diversity, Time Diversity.

UNIT- IV MULTIPLE ACCESS TECHNIQUES 9

Introduction: Introduction To Multiple Access- Frequency Division Multiple Access(FDMA)- Time Division Multiple Access(TDMA)- Spread Spectrum Multiple Access-Code Division Multiple Access(CDMA)- Space Division Multiple Access(SDMA)- **Capacity Of Cellular Systems**: Capacity Of Cellular CDMA, Capacity Of CDMA With Multiple Cells.

UNIT- V WIRELESS NETWORKING 9

Introduction: Difference Between Wireless And Fixed Telephone Networks, The Public Switched Telephone Network(PSTN), **Development Of Wireless Networks:** First Generation Wireless Networks, Second Generation Wireless Networks, Third Generation Wireless Networks, Fixed Network Transmission Hierarchy, **Traffic Routing In Wireless Networks:** Circuit Switching, Packet Switching-**Personal Communication Services/ Networks(PCS/PCNs):**Packet Vs Circuit Switching For PCN, Cellular Packet- Switched Architecture- Packet Reservation Multiple Access(PRMA)- **Network Databases:** Distributed Database For Mobility Management- Universal Mobile Telecommunication Systems(UMTS).

45 PERIODS

PRACTICAL EXERCISES: **30 PERIODS**

1. Modeling of wireless communication systems using Matlab (Two ray channel and Okumura –Hata model)
2. Modeling and simulation of Multipath fading channel
3. Design, analyze and test Wireless standards and evaluate the performance measurements such as BER, PER, BLER, throughput, capacity, ACLR, EVM for 4G and 5G using Matlab
4. Modulation: Spread Spectrum – DSSS Modulation & Demodulation
5. Wireless Channel equalization: Zero-Forcing Equalizer (ZFE),MMSE Equalizer(MMSEE),Adaptive Equalizer (ADE),Decision Feedback Equalizer (DFE)
6. Modeling and simulation of TDMA, FDMA and CDMA for wireless communication

TOTAL:75 PERIODS

COURSE OUTCOMES:

Upon successful completion of the course the student will be able to:

CO1: Understand the Concept And Design Of A Cellular System.
CO2: Understand Mobile Radio Propagation And Various Digital Modulation Techniques.
CO3: Understand the Concepts Of Multiple Access Techniques And Wireless Networks
CO4: Characterize a wireless channel and evolve the system design specifications
CO5: Design a cellular system based on resource availability and traffic demands.

TEXT BOOK :

1. Rappaport,T.S.,-Wireless communications", Pearson Education, Second Edition, 2010.

REFERENCES:

1. Wireless Communication –Andrea Goldsmith, Cambridge University Press, 2011
2. Van Nee, R. and Ramji Prasad, ―OFDM for wireless multimedia communications, Artech House, 2000
3. David Tse and Pramod Viswanath, ―Fundamentals of Wireless Communication, Cambridge University Press, 2005.
4. Upena Dalal, ―Wireless Communication", Oxford University Press, 2009.
5. Andreas.F. Molisch, ―Wireless Communications", John Wiley – India, 2006.
6. Wireless Communication and Networks –William Stallings ,Pearson Education, Second Edition 2002.

CO's-PO's & PSO's MAPPING

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
1	3	2	2	3	3	1	-	-	-	-	-	1	3	1	1
2	3	3	2	1	3	2	-	-	-	-	-	-	3	1	2
3	3	3	3	3	2	2	-	-	-	-	-	1	3	1	2
4	2	3	2	2	2	2	-	-	-	-	-	1	2	1	1
5	2	-	3	3	2	1	-	-	-	-	-	1	2	2	2
CO	3	3	2	2	2	2	-	-	-	-	-	1	3	1	2

UNIT-I
CELLULAR CONCEPT SYSTEM DESIGN FUNDAMENTALS

TWO MARKS

1. **Write the cellular concept. (or)**
   Why is cellular concept used for mobile telephony? [May 2017]

   If a given set of frequencies or radio channels can be reused without increasing the interference, then the large geographical area covered by a single high power transmitter can be divided into a number of small areas, each allocated power transmitters with lower antennas can be used.

2. **Why hexagon shape was selected for cell?**

   The Hexagon shape was chosen for cell because it provides the most effective transmission by approximating a circular pattern while eliminating gaps present between adjacent circles.

3. **Differentiate between macro cells and microcells.**

   The physical size of a cell varies, depending on user density and calling patterns.
   - ✓ Macro cells are large cells typically have a radius between 1 mile and 15 miles with base station transmit powers between 1W and 6W.
   - ✓ Microcells are the smallest cells typically have a radius between of 1500 feet or less with base station transmit powers between 0.1W and 1W.

4. **Mention the need of Pico cells.**
   - ✓ Cellular radio signal are to week to provide reliable communication at indoor, especially in well-shielded areas or areas with high levels of interference.
   - ✓ To overcome this, very small cells called Pico cells are used in same frequencies as regular cells in the same areas.

5. **Define cell & cell cluster.**
   - ✓ Each cellular base station is allocated a group of radio channels to be used with a small geographic area called a cell.
   - ✓ A group of cells that use a different set of frequencies in each cell is called a cell cluster.

6. **Based on the location of BS, how cells are classified?**
   - ✓ When designing a system using hexagonal-shaped cells, main consideration is the location of the base station transmitters.
     - ➢ Center-excited cell- Base station transmitters can be located in the center of the cell and uses Omni directional antennas which radiate and receive signals equally well in all directions.
     - ➢ Edge- excited cell- Base station transmitters can be located in the edge of the cell and uses sectored antennas which radiate for a particular direction.
     - ➢ Corner- excited cell- Base station transmitters can be located in the corner of the cell and uses sectored directional antennas.

FREQUENCY REUSE

7. **Define Frequency reuse. [May 2016, May 2013, Nov 2016, Nov/Dec 2017, April/May 2018, 2021], [Nov/Dec 2021][April/May 2023]**
   - ✓ The design process of selecting and allocating channel groups for all of the cellular base stations within a system is called frequency reuse or frequency planning.

- ✓ Physical separation of two cells is sufficiently wide; the same subset of frequencies can be used in both cells.
  - This is the concept of frequency reuse.
  - The same spectrum can support multiple users and available spectrum is efficiently utilized.

8. Define foot print.

- ✓ The actual radio coverage of a cell is known as the foot print. It is determined from field measurement or propagation prediction models.

9. Express the total number of channels available in cluster.

For total number of cellular channels available in a cluster can be expressed mathematically as ***S=Kn***

Where, S-Number of full-duplex cellular channels available in cluster.

K-Number of channels in a cell and

n-Number of cells in a cluster.

10. What are the rules used to determine the nearest co channel neighbors?

The following two-step rules can be used to determine the location of the nearest co channel cell:

Step 1: Move I cells along any chain of hexagons;

Step 2: Turn 60 degrees counter clockwise and more j cells.

11. Write the expression for cellular system capacity.

Let M be the number of times the cluster is replicated and C be the total number of channels used in the entire cellular system with frequency reuse. C is then the system capacity and is given by **C=MKn; C=MS**

Where C- Total channel capacity in a given area

M-Number of clusters in a given area

12. Define FRF.

The number of user use the same set of frequencies is called the frequency reuse factor (FRF) and is defined mathematically as

$$\mathbf{FRF} = \frac{\boldsymbol{N}}{\boldsymbol{C}}$$

Where N-Total number of full-duplex channels in an area

C-Total number of full-duplex channels in a cell.

HAND OFF

13. Write the advantages of cellular systems?

- ✓ The advantages of Cellular Systems:
  - The use of low power transmitter and
  - It allows frequency reuse for capacity improvement.

14. Define Dwell time.

The time over which a call may be maintained within a cell, without handoff, is called the dwell time.

15. What are the methods used for handoffs?

Depending on the information used and the action taken to initiate the handoff, the methods for handoff can be

- Mobile Controlled Hand off (MCHO)

- Network Controlled Hand off (NCHO) and
- Mobile Assisted Hand off (MAHO)

16. Write about umbrella cell approach and its usage.

- ✓ By using different antenna heights (same building or tower) and different power levels, it is possible to provide "large" and" small" cells which are co-located at a single location.
- ✓ The umbrella cell approach is used to provide large area coverage to high speed users while providing small area coverage to users travelling at low speeds.

17. Write a short note on hard handoff and Soft handoff.

What is soft handoff in mobile communication? [May 2016]

- ✓ **Hard Handoff:** If the MSC monitors the strongest signal base station and transfer the call to that base station then it is called hard handoff.
- ✓ **Soft handoff:** Mobile communicates with two or more cells at the same time and find which one is a strongest signal base station then it automatically transfers the call to that base station is called soft handoffs.

18. In a cellular network, among a handoff call and new call, which one is given priority? Why? [April 2017]

- ✓ Different systems have different methods for handling and managing handoff request.
- ✓ Some systems handle handoff in same way as they handle new originating call.
- ✓ In such system the probability that the handoff will not be served is equal to blocking probability of new originating call.
- ✓ But if the call is terminated abruptly in the middle of conversation then it is more annoying than the new originating call being blocked.
- ✓ So in order to avoid this abrupt termination of ongoing call handoff request should be given priority to new call this is called as handoff prioritization.

19. What are the techniques used to prioritize the handoff call and new call?

There are two techniques for this:

Guard Channel Concept

In this technique, a fraction of the total available channel in a cell is reserved exclusively for handoff request from ongoing calls which may be handed off into the cell.

Queuing

Queuing of handoffs is possible because there is a finite time interval between the time the received signal level drops below handoff threshold and the time the call is terminated due to insufficient signal level. The delay size is determined from the traffic pattern of a particular service area.

20. Mention the limitations of cellular communication systems? [June 2013]

Limitations of cellular communication systems

i. fixed network needed for the base stations
ii. handover (changing from one cell to another) necessary
iii. interference with other cells

21. What are the reasons for handover? [Nov 2013]

There are different reasons for handover:

i. When the phone is moving away from the area covered by one cell and entering the area covered by another cell, the call is transferred to the second cell, in order to avoid call

termination.

ii. When the capacity for connecting new calls of a given cell is used up and an existing or new call from a phone is transferred to that cell in order to free-up some capacity in the first cell.

22. Write the features of handoff.

- ✓ Fast and lossless
- ✓ Minimal number of control signal exchanges.
- ✓ Scalable with network size.
- ✓ Capable of recovering from link failures and
- ✓ Efficient use of resources.

CHANNEL ASSIGNMENT

23. Name the two channels assignments.

- ✓ There are essentially two channels assignment approaches
  - Fixed channel assignment and
  - Dynamic channel assignment

24. What is FCA?

- ✓ In FCA, each cell is allocated a predetermined (permanently) set of voice channels. Any call attempt within the cell can only be served by the unused channels in that particular cell.

25. Define borrowing strategy.

- ✓ To improve utilization, a borrowing option may be considered borrowing strategy; a cell is allowed to borrow channels from a neighboring cell if all of its own channels are already occupied.

26. What do you meant by DCA? Give its advantages.

- ✓ In DCA, voice channels are not allocated to different cells permanently. Each time a cell request is made, the serving base station request a channel from the MSC.
- ✓ Dynamic channel assignment reduces the call blocking, which increases the trucking capacity of the system, since all available channel under the control of the MSC are accessible to the entire cell.

27. Define co-channel reuse ratio. [Nov 2015]

The co-channel reuse ratio Q is defined as

$$Q = \frac{D}{R}$$

Where,

D - Distance between centers of the nearest co-channel cells

R - Radius of the cell

28. Mention a few techniques used to expand the capacity of a cellular system. [May 2015]

Cell splitting, Sectoring, Coverage Zone approaches are the techniques used to expand the capacity of cellular system.

Cell splitting

- Cell-splitting is a technique which has the capability to add new smaller cells in specific areas

of the system. i.e. divide large cell size into small size.

Sectoring

- use of directional antennas to reduce Co-channel interference.
- Coverage Zone approaches
- Large central BS is replaced by several low power transmitters on the edge of the cell.

29. Define co-channel Interference. [Nov 2015, May 2016]

- ✓ Co-channel interference is caused due to the cells that reuse the same frequency set.
- ✓ The cells using the same frequency set are called co-channel cells.
- ✓ The interference between signals from the co-channel cells is called co-channel interference.

30. Define adjacent channel Interference.

- ✓ Interference resulting from signals which are adjacent in frequency to the desired signal is called adjacent channel interference.
- ✓ Adjacent channel interference results from imperfect receiver filters that allow nearby frequencies to leak into the passband.

31. What do you mean by forward and reverse channel? [Nov/Dec 2017]

- ✓ The channels used for transmission from the base station to mobiles are called ***forward channels***
- ✓ The channels used for transmission from mobiles to the base station are called ***reverse channels***.

QUESTION BANK

UNIT-I

THE CELLULAR CONCEPT-SYSTEM DESIGN FUNDAMENTALS

PART – A

1. What is multiple access technique?
2. What is the tradeoff that exists between system capacity and coverage?
3. Write down the procedure involved in the determination of Co-Channel Cell.
4. What do you mean by mobile – assisted handoff?
5. How FDMA handles near-far problem?
6. What do you mean by forward and reverse channel?
7. Mention the limitations of cellular communication systems?
8. What are the reasons for handover?
9. In a cellular network, among a handoff call and new call, which one is given priority? Why?
10. Define Frequency reuse.
11. Why is cellular concept used for mobile telephony?
12. What are the disadvantages of TDMA?
13. State the difference between Narrowband and wideband systems.
14. What are the different types of multiple access schemes?
15. Mention some features of FDMA.

PART – B & C

1. Explain the concept of cellular topology and cell fundamentals. [Dec 2015, May 2023]
2. Discuss in detail about frequency reuse. [8m] [Dec 2014, Dec 2021]
3. Explain channel assignment in detail. [April/May 2018]
4. Explain the principle of cellular networks and various types of handoff techniques. [May 2016, May 2013, Dec 2014, Dec 2019, May 2018, May 2019, May 2021, May 2023]
5. Describe various interferences and increasing the system capacity of wireless cellular networks. [May 2021, Dec 2021]
6. Write short notes on i) Trunking ii) Grade of service of cell system. [Dec 2017, May 2019, Dec 2019]
7. Explain in detail how to improve coverage and channel capacity in cellular systems. [Nov 2015, May 2016, Dec 2019, May 2013, May 2010, May 2019**]**

*****

TWO MARKS

1. What is meant by multipath propagation? [Nov/Dec 2017]

Multipath propagation:

- ✓**Multipath** means the transmitted signal may arrive at the receiver over many paths.
- ✓The signal gets reflected and diffracted by different objects. So, each of the paths have a distinct amplitude, delay and direction of arrival.
- ✓This effect is known as multipath propagation

2. What is the major advantage of wireless communication?

Advantages of wireless communications:

- ✓ **Mobility:** The users have freedom to move.
- ✓ **Increased reliability:** Use of wireless technology eliminate cable failures, so overall reliability
- ✓ **Ease of installation:**
- ✓ **Rapid disaster recovery:** Accidents may happen due to fire, etc., the organization hot prepared to recover such natural disasters.
- ✓ **Low cost**

3. What is the significance of propagation model?

The major significance of propagation model is:

i. Propagation model predicts the parameter of receiver.

ii. It predicts the average received signal strength at a given distance from the transmitter.

4. What are the types of propagation models?

The two types of propagation models are

Large Signal Propagation Models	Small Scale Fading Models
They characterize signal strength over large transmitter-receiver separation distances. e.g., several hundred or 1000s of meters.	They characterize signal strength over short travel distance. e.g., mobile moves over small distance, for cellular and PCS frequencies in the 1 GHz to 2 GHz band, coverage area from 1 m to 10 m.

5. Define large scale propagation. [Nov 2010]

Large-scale propagation models predict the mean signal strength for an arbitrary transmitter-receiver (T-R) separation distance, which are useful in estimating the radio coverage area of a transmitter and they characterize signal strength over large T-R separation distances.

6. Define path loss. [Nov 2012]

Path loss: The path loss is defined as the difference (in Db) between the effective transmitted power and the received power. Path loss may or may not include the effect of the antenna gains.

7. What is free space propagation model?

Free space propagation model: The free space propagation model is used to predict received signal strength, when the transmitter-receiver has a clear, line of sight path between them.

8. What is free space propagation model? Write the expression for free space path loss. [June 2013][April/May 2023]

Free space propagation model: The free space propagation model is used to predict received signal strength, when the transmitter-receiver has a clear, line of sight path between them.

The path loss for the free space model when antenna gains are included is given by

$$PL(dB) = 10\log\frac{P_t}{P_r} = -10\log\left[\frac{G_t G_r \lambda^2}{(4\pi)^2 d^2}\right]$$

The path loss for the free space model when antenna gains are excluded is given by

$$PL(dB) = 10\log\frac{P_t}{P_r} = -10\log\left[\frac{\lambda^2}{(4\pi)^2 d^2}\right]$$

9. Write an expression for free space propagation model.

The received power is given by the Friis free space equation as

$$P_{RX} = P_{TX} G_{RX} G_{TX} \left(\frac{\lambda}{4\pi d}\right)^2$$

where, P_{tx} → transmitted power
P_{RX} → the received power
G_{TX} → the transmitter antenna gain
G_{RX} → the receiver antenna gain
d → the transmitter-receiver separation distance in meter
λ → Wavelength in meters

10. List the different types of propagation mechanisms. [Nov 2014]

The different types of propagation mechanisms include

- ✓ Reflection
- ✓ Diffraction
- ✓ Scattering

11. What is reflection?

Reflection:

Reflection occurs when a propagating electromagnetic wave impinges upon an object, which has very large dimension when compared to the wavelength of propagating wave.

12. What is diffraction?

Diffraction:

Diffraction occurs when the radio path between the transmitter and receiver is obstructed by a surface that has sharp irregularities

13. Which factors does diffraction depend on at high frequencies? [Nov/Dec 2019]

The amount of diffraction depends on the size of the obstacle or opening in relation to the wave length of the wave.

14. What is scattering?

Scattering:

Scattering occurs when the medium through which the wave travels consists of objects with dimensions that are small compared to the wavelength and where the number of obstacles per unit volume is large.

15. What is small-scale fading? [Nov/Dec 2021]

Small-scale fading, due to the constructive and destructive interference of the multiple signal paths between the transmitter and receiver. This occurs at the spatial scale of the order of the carrier wavelength, and is frequency dependent.

16. What is large scale fading?or shadow fading? Why it is called so? [Nov/Dec 2019]

Large-scale fading, due to path loss of signal as a function of distance and shadowing by large objects such as buildings and hills. This occurs as the mobile moves through a distance of the order of the cell size, and is typically frequency independent

17. State the difference between small-scale fading and large-scale fading. [May 2015, May 2013][April/May 2019]

Large-scale fading	Small-scale fading
The rapid fluctuations of the amplitudes, phases, or multipath delays of a radio signal over a long period of time or travel distance is known as	The rapid fluctuations of the amplitudes, phases; or multipath delays of a radio signal over a short period of time or travel distance is known as

large scale fading.	small scale fading.

18. Find the far-field distance for an antenna with maximum dimension of 2 m and operating frequency of 1GHz. [Nov 2015, Nov 2016]

Given:

Largest dimension of antenna, D = 2 meter

Operating frequency, f = 1GHz

To Find:

Far field distance, d_f

Solution:

$$\lambda = \frac{c}{f} = \frac{3\times10^8 m/s}{1\times10^9 Hz} m = 0.3\text{m}$$

Far field distance, $d_f = \frac{2D^2}{\lambda}$

$$= \frac{2(2)^2}{0.3} = 26.27\ m$$

19. Calculate the Brewster angle for wave impinging on ground having a permittivity ε_r = 5. [May 2016, Dec 2009]

Given:

Permittivity, ε_r =5

To find:

Brewster angle for wave

Solution:

$$\sin(\theta_i) = \frac{\sqrt{\varepsilon_r - 1}}{\sqrt{\varepsilon_r^2 - 1}} = \frac{\sqrt{(5)-1}}{\sqrt{(5)^2 - 1}} = \sqrt{\frac{4}{24}} = 0.4082$$

$$\theta_i = \sin^{-1}(0.4082) = 24.09^0$$

The Brewster angle for ε_r =5 is equal to 24.09^0

20. Calculate the Brewster angle for wave impinging on ground having a permittivity ε_r =4. (8m – May 2015, 8m – Nov 2013]

Given: Permittivity, ε_r =4

To find:

Brewster angle for wave

Solution:

$$\sin(\theta_i) = \frac{\sqrt{\varepsilon_r - 1}}{\sqrt{\varepsilon_r^2 - 1}} = \frac{\sqrt{(4)-1}}{\sqrt{(4)^2 - 1}} = \sqrt{\frac{3}{15}} = 0.577$$

$$\theta_i = \sin^{-1}(0.577) = 24.090$$

The Brewster angle for ε_r =4 is equal to 24.090

21. Interpret Snell's law. [May 2015, May 2013]

Snell's law state that

$$\sqrt{\mu_1\varepsilon_1}\sin(90-\theta_i) = \sqrt{\mu_2\varepsilon_2}\sin(90-\theta_t)$$

μ_1, μ_2 → Permittivity of two media

ε_1,ε_2 → Permeability of two media

θ_i → Incident angle, θ_t → Transmitted angle

22. List the advantages and disadvantages of 2 ray ground reflection model in the analysis of model in the analysis of path loss. [Dec 2012]

Advantages of 2 ray model:

- The 2 Ray model gives more accurate prediction at a long distance than the free space model.
- models predicts the mean received power at distance
- The 2 Ray model is used for mobile radio channels

Disadvantages of **2 ray model**:

- The formula is not applicable for short distances like 10 meters. Not accurate for a distance less than approximately 4.7 Km for GSM 1800.
- The two-ray model does not give a good result for a short distance due to the oscillation caused by the constructive and destructive combination of the two rays.
- Generally, the transmitter antenna height will be at least 10 meters to clear trees and buildings.

23. What are the three most important effects of small-scale multipath propagation?

State the propagation Effects in mobile radio. [May 2014]

The three most important effects of small-scale multipath propagation are

1. Rapid changes in signal strength over a small travel distance or time interval.
2. Random frequency modulation due to varying Doppler shifts on different multipath signals.
3. Time dispersion (echoes) caused by multipath propagation delays.

24. What is Doppler shift?

Doppler shift:

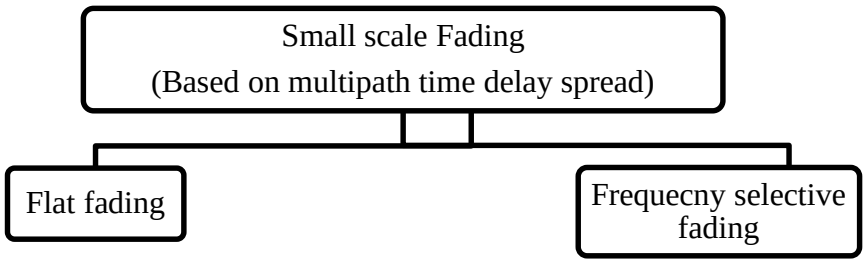
If the receiver is moving towards the source, then the zero crossings of the signal appear faster and the received frequency is higher. The opposite effect occurs if the receiver is moving away from the source. The resulting chance in frequency is known as the Doppler shift (f_D).

25. Differentiate the propagation effects with mobile radio. (or)

Compare fast and slow fading. [April/May 2018]

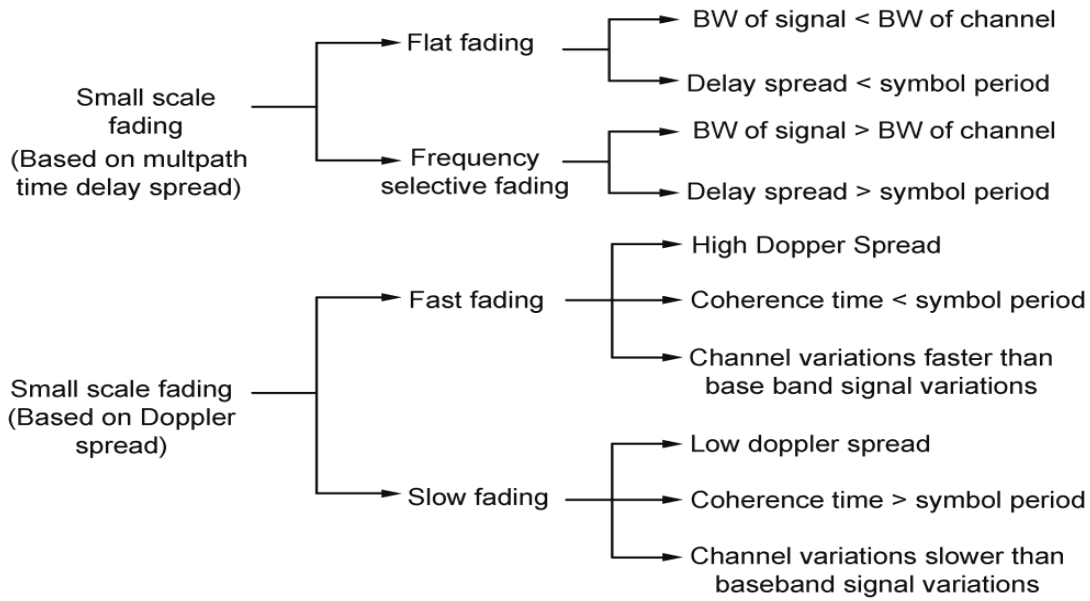
Slow Fading	Fast Fading
Slow variations in the signal strength	Rapid variations in the signal strength.
Mobile station (MS) moves slowly	Local objects reflect the signal causes fast fading.
It occurs when the large reflectors and diffracting objects along the transmission paths are distant from the terminal.	It occurs when the user terminal (MS) move for short distances.

26. What are the different fading effects due multipath time delay spread?

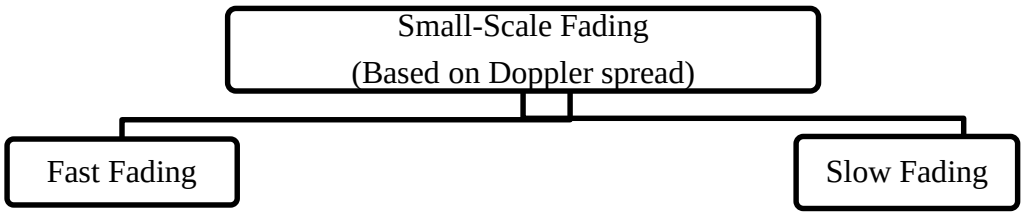


1. Bandwidth of signal < Bandwidth of channel	1. Bandwidth of signal > Bandwidth of channel
2. Delay spread < Symbol period	2. Delay spread > Symbol period

27. What are the types of small scale fading? [May 2013]



28. What are the different fading effects due to Doppler spread? [Nov 2014]



1. High Doppler spread
2. Coherence time < Symbol period
3. Channel variations faster than baseband signal variations

1. Low Doppler spread
2. Coherence time > Symbol period
3. Channel variations slower than baseband signal variations

29. Define coherence time and coherence bandwidth. [May 2016, Nov 2015, Nov 2016]

Coherence time is the maximum duration for which the channel can be assumed to be approximately constant. It is the time separation over which two received signals have strong potential for amplitude correlation.

Coherence bandwidth is the maximum frequency difference for which signals are strongly correlated in amplitude.

30. Give the Friis free space equation.[April/May 2023]

The ***Friis free space equation*** is given by

$$P_r(d) = \frac{P_t G_t G_r \lambda^2}{(4\pi)^2 d^2 L}$$

where, $P_r(d) \rightarrow$ Received power

$P_t \rightarrow$ Transmitted power

$G_t \rightarrow$ Transmitter antenna gain

$G_r \rightarrow$ Receiver antenna gain

$d \rightarrow$ T-R separation distance in meters

$\lambda \rightarrow$ Wavelength in meters

$L \rightarrow$ System loss factor

31. Define EIRP.

EIRP:

EIRP (Equivalent Isotropic Radiated Power) of a transmitting system in a given direction is defined as the transmitter power that would be needed, with an isotropic radiator, to produce the same power density in the given direction.

$EIRP = P_t.G_t$

where P_t - transmitted power in W, G_t – transmitting antenna gain

32. Give the formula to calculate Fraunhofer distance.

Fraunhofer distance is given by

$$d_f = \frac{2D^2}{\lambda}$$

where, D → Largest physical linear dimension of the antenna.

D_f → Far-field distance

λ → Wavelength in meters

33. When miscellaneous loss occurs?

The miscellaneous losses L are usually due to

- ✓ Transmission line attenuation
- ✓ Filter losses
- ✓ Antenna losses in the communication system.

34. Define path loss.

Path loss:

The path loss is defined as the difference (in Db) between the effective transmitted power and the received power. Path loss may or may not include the effect of the antenna gains.

35. Give the path loss for the free space model.

The path loss for the free space model when antenna gains are included is given by

$$PL(dB) = 10\log\frac{P_t}{P_r} = -10\log\left[\frac{G_t G_r \lambda^2}{(4\pi)^2 d^2}\right]$$

The path loss for the free space model when antenna gains are excluded is given by

$$PL(dB) = 10\log\frac{P_t}{P_r} = -10\log\left[\frac{\lambda^2}{(4\pi)^2 d^2}\right]$$

36. Give the path loss for the 2-ray model.

The path loss for the 2-ray model (with antenna gains) can be expressed in Db as

$$PL(dB) = 40\log d - (10\log G_t + 10\log G_r + 20\log h_t + 20\log h_r)$$

where,

h_t → Height of the transmitter

h_r → Height of the receiver.

d → T-R separation distance in meters

G_t → Transmitter antenna gain

G_r → Receiver antenna gain

37. What is the necessity of link budget?

The necessities of link budget are:

i. A link budget is the clearest way of computing the required transmitter power. It tabulates all equations that connect the Transmitter to the received SNR.

ii. It is reliable for communications.
iii. It is used to ensure the sufficient receiver power is available.
iv. To meet the SNR requirement link budget is calculated.

38. Express Log-distance Path Loss Model mathematically.

Average received signal power decreases logarithmically with distance.

$$\overline{PL}(d) \propto \left(\frac{d}{d_0}\right)^n$$

$$\overline{PL}(dB) = \overline{PL}(d_0) + 10n\log\left(\frac{d}{d_0}\right)$$

where,

$\overline{PL}(d) \rightarrow$ Average large-scale path loss
d $\rightarrow$ T-R separation
d_0 $\rightarrow$ Close-in reference distance
n $\rightarrow$ Path loss exponent

39. Differentiate ISI, fading, attenuation, shadowing and small scale, large scale fading? [Nov/dec 2012]

What are the two factors that contribute to the rapid fluctuations of the signal amplitude? [April/May 2019]

ISI: Signal dispersion leads to Inter Symbol Interference (ISI) at the Receiver.

Fading: Variations in signal strength are known as fading. It describes how the received signal amplitude changes with time.

Small Scale Fading is used to describe the rapid fluctuations of the amplitudes, phases or multipath delays of a radio signal over a short period of time. Wavelength $\lambda \simeq 1\ m$

Attenuation: It is the drop in the signal power when transmitting from one point to another.

Shadowing of the signal can occur whenever there is an obstruction between the transmitter and receiver.

Eg., buildings and hills

Large-scale fading causes signal power attenuation due to motion over large area.

Eg., large terrain (ex. Hills, forest, billboard…) between the transmitter and the receiver

40. Define shadowing. [Nov 2012]

Shadowing of the signal can occur whenever there is an obstruction between the transmitter and receiver.

41. Give various small scale fading parameters of Mobile Multipath Channels? [Dec 2012]

Small scale fading parameters of Mobile Multipath Channels

(i) Mean excess delays

(ii) RMS delay spread

(iii) Excess delay spread

42. Express Log-normal shadowing mathematically.

The path loss PL(d) at a particular location is random and distributed log-normally (normal in Db) about the mean distance dependent value .That is

$$PL(d)[dB] = \overline{PL}(d) + X_\sigma = \overline{PL}(d_0) + 10n\log\left(\frac{d}{d_0}\right) + X_\sigma$$

$$P_r(d)[dBm] = P_t[dBm] - PL(d)[dB]$$

where X_σ → Zero-mean Gaussian distributed random variable (in Db)

σ → Standard deviation (in Db)

43. What is flat fading? [Nov 2012, Nov /Dec 2017]

If the mobile radio channel has a constant gain & linear phase response over a bandwidth which is greater than the bandwidth of the transmitted signal, then the received signal will undergo flat fading.

44. What is frequency selective fading? How to avoid fading problem? [May 2012]

If the channel has a constant gain & linear phase response over a bandwidth that is smaller than the bandwidth of the transmitted signal, then the channel creates frequency selective fading on the received signal.

45. What are the factors influencing small scale fading?

- ✓ The factors influencing small scale fading are multipath propagation, speed of the mobile, speed of surrounding objects and the transmission bandwidth of the signal.
- ✓ Narrow band signal with bandwidth B > B_C, then the channel behaves like frequency selective fading.
- ✓ It occurs when

$$T_s \approx \frac{1}{B} \quad \frac{1}{B_c} \approx \sigma T_m \quad \text{causes performance degradation}$$

Where,

σTm → rms delay spread

Ts → Symbol duration

B → Bandwidth

Bc → Coherence bandwidth

46. Define mean excess delay and rms delay spread. [Nov 2015]

- ✓ The mean excess delay is the first moment of the power delay profile and is defined to be

$$\bar{\tau} = \frac{\sum_k a_k^2 \tau_k}{\sum_k a_k^2} = \frac{\sum_k P(\tau_k)\tau_k}{\sum_k P(\tau_k)}$$

- ✓ The rms delay spread is the square root of the second central moment of the power delay profile and is defined to be

$$\sigma_\tau = \sqrt{\overline{\tau^2} - (\bar{\tau})^2}$$

where, $$\overline{\tau^2} = \frac{\sum_k a_k^2 \tau_k^2}{\sum_k a_k^2} = \frac{\sum_k P(\tau_k)\tau_k^2}{\sum_k P(\tau_k)}$$

47. When a signal undergoes flat fading? (or) State the condition for the occurrence of Flat Fading. [April/May 2021]

A signal undergoes flat fading if

$$B_S << B_c$$

$$T_S >> \sigma_\tau$$

where Bs → Signal Bandwidth.
Bc → Coherence bandwidth
Ts → Reciprocal bandwidth
$\sigma\tau$ → rms delay spread

48. When a signal will undergoes frequency selective fading? (or)
State the condition for the occurrence of Frequency Selective Fading. [April/May 2021]

A signal undergoes frequency selective fading if

$$B_S > B_c$$

$$T_S < \sigma_\tau$$

where B_s → Signal Bandwidth.
B_c → Coherence bandwidth
T_s → Reciprocal bandwidth
σ_τ → *rms* delay spread

49. When a signal undergoes fast fading?

A signal undergoes fast fading if

$$T_S > T_c$$

$$B_S < B_D$$

where B_S → Bandwidth of the transmitted modulation

T_S → Reciprocal bandwidth of the transmitted modulation

50. When a signal will undergo slow fading?

A signal undergoes fast fading if

$$T_S << T_c$$

$$B_S >> B_D$$

where B_S → Bandwidth of the transmitted modulation

T_S → Reciprocal bandwidth of the transmitted modulation

51. State the difference between small-scale and large-scale propagation.

LARGE-SCALE PROPAGATION	SMALL-SCALE PROPAGATION
Predicts the mean signal strength for an arbitrary transmitter-receiver (T-R) separation distance are useful in estimating the radio coverage area of a transmitter is called large-scale propagation	Rapid fluctuations of the received signal strength over very short travel distance/short duration are called Small-scale propagation.
As the mobile moves away from transmitter over large distances, the local average received signal will gradually decrease	As the mobile moves away from transmitter over small distances, , the received signal may fluctuate, giving rise to small scale fading

52. What is fading and Doppler spread? [Nov 2013, Nov 2016]

- ✓ **Fading:** The term small-scale fading or simply ***fading***, means rapid fluctuations of the amplitudes, phases, or multipath delays of a radio signal over a short period of time or short travel distance, so that the large scale path loss effects may be ignored
- ✓ **Doppler spread:** Doppler spread B_D is a measure of the spectral broadening caused by the time rate of change of the mobile radio channel.

53. What is Doppler spread? [May 2016]

- ✓ Doppler spread B_D is a measure of the spectral broadening caused by the time rate of change of the mobile radio channel.
- ✓ Doppler spread B_D is defined as the range of frequencies over which the received Doppler spectrum is essentially non-zero.

54. Distinguish between Narrowband and Wideband systems. [DEC 2012, DEC 2013]

Sl. No.	Narrow band system	Wide band system
1.	In narrow band system, the available radio spectrum is divided into a large number of narrowband channels.	In wideband systems, the transmission bandwidth of a single channel is much larger than the coherence bandwidth of the channel.
2.	Small delay spread	Large delay spread
3.	High coherence bandwidth	Small coherence bandwidth

55. What is coherence bandwidth? [April/May 2021]

- ✓ Coherence bandwidth is defined as the bandwidth over which the frequency correlation function is above 0.9

$$B_C = \frac{1}{50\,\sigma_\tau}$$

If the frequency correlation function is above 0.5, then

$$B_C = \frac{1}{5\,\sigma_\tau}$$

$\sigma_\tau \rightarrow rms$ delay spread

What is meant by Doppler spread?

- ✓ Doppler Spread is defined as the range of frequencies over which the received Doppler spectrum is essentially non-zero.

$F_c \rightarrow$ Pure sinusoidal tone of frequency

$f_d \rightarrow$ Doppler shift

- ✓ If f_c is transmitted then received Doppler spectrum will have components

spectrum=$f_c + f_d$ and $f_c - f_d$

56. Define coherence time. In what way does this parameter decide the behavior of wireless channel? [April 2017, Dec 2015, April/May 2021]

- ✓ Coherence time is the time over which two signals are having strong potential for amplitude correlation.
- ✓ The Doppler spread and coherence time are inversely proportional to one another.

$$Cohrence\ Time = \frac{1}{Doppler\ Spread}$$

57. Define mean excess delay. [Dec 2015]

Mean excess delay

- ✓ The mean excess delay is the first moment of the power delay profile (PDP).
- ✓ It is expressed as

$$\bar{\tau} = \frac{\sum_k a_k^2 \tau_k}{\sum_k a_k^2} = \frac{\sum_k P(\tau_k)\tau_k}{\sum_k P(\tau_k)}$$

58. Define RMS delay spread. [Dec 2015]

RMS delay spread

✓ The *rms* delay spread is the square root of the second central moment of the power delay profile.

$$\sigma_\tau = \sqrt{\overline{\tau^2} - \left(\overline{\tau}\right)^2}$$

$$\overline{\tau^2} = \frac{\sum_k a_k^2 \tau_k^2}{\sum_k a_k^2} = \frac{\sum_k P(\tau_k)\tau_k^2}{\sum_k P(\tau_k)}$$

where,

σ_τ → *rms* delay spread

a_k → Amplitude

$P(\tau_k)$ → Relative power levels of the individual multipath components

τ_k → Excess delay

***59.* Define maximum excess delay. [Dec 2015]**

Maximum excess delay

✓ The maximum excess delay (X Db) of the power delay profile is defined to be the time delay during which multipath energy falls to X Db below the maximum.

✓ The maximum excess delay is defined $\tau_x - \tau_0$ as

Where, τ_0 → First arriving signal

τ_x → Maximum delay at which a multipath component is within X Db of the strongest multipath signal

✓ Maximum excess delay is sometimes called the ***excess delay spread***.

59. Give the difference between frequency flat and frequency selective fading. [April/May 2018][April/May 2022]

Sl. No.	**Flat fading**	**Frequency selective fading**
1.	Bandwidth of signal < Bandwidth of channel	Bandwidth of signal > Bandwidth of channel
2.	Delay spread < Symbol period	Delay spread > Symbol period

****

QUESTION BANK
UNIT-II
MOBILE RADIO PROPAGATION

PART – A

1. What is meant by multipath propagation?
2. Define large scale propagation.
3. Define path loss.
4. What is free space propagation model? Write the expression for free space path loss.
5. List the different types of propagation mechanisms.
6. Which factors does diffraction depend on at high frequencies?
7. State the difference between small-scale fading and large-scale fading.
8. State the propagation Effects in mobile radio.
9. Compare fast and slow fading.
10. What are the types of small scale fading?
11. Define coherence time and coherence bandwidth.
12. Differentiate ISI, fading, attenuation, shadowing and small scale, large scale fading?
13. Give various small scale fading parameters of Mobile Multipath Channels?
14. What is flat fading?
15. What is fading and Doppler spread?
16. What is coherence bandwidth?
17. Distinguish between Narrowband and Wideband systems.
18. Define coherence time. In what way does this parameter decide the behavior of wireless channel?
19. Define maximum excess delay.
20. Give the difference between frequency flat and frequency selective fading.

PART – B

1. Describe briefly about free space propagation model. [May 2014, Nov 2012, May 2012, May 2019, May 2021, May 2023]
2. Explain the different types of multipath propagation in wireless communication. [May 2016, May 2015, Nov 2013, Nov 2012, Nov 2014]
3. Discuss the impact of time dispersion parameter, Coherence Bandwidth, Doppler Spread and Coherence time on small scale fading. [May 2021]
4. Show that a flat fading channel occurs when $T_s >= 100\sigma_\tau$. [April/May 2018]
5. Derive the path loss for large scale propagation in a multipath wireless environment.–What is Doppler spread? [April 2010]
6. Explain in detail about types of Small Scale Fading. [May 2010, May 2019, May 2023, Dec 2019]
7. Examine the effectiveness of flat fading and frequency selective fading. [May 2019, Dec 2019]

****

UNIT- III
MODULATION TECHNIQUES AND EQUALIZATION AND DIVERSITY
TWO MARKS

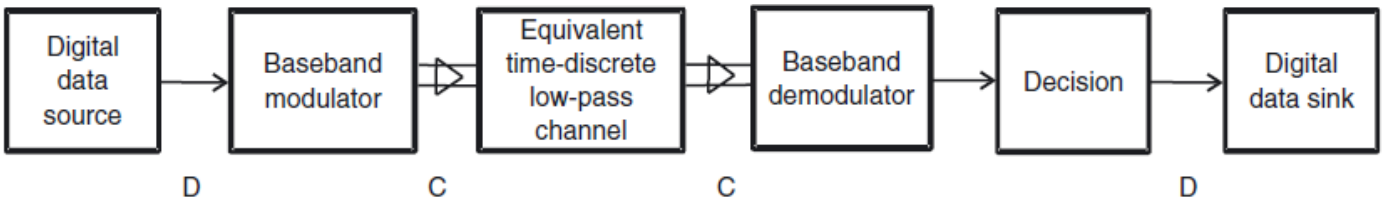
1. What are the steps involved in the wireless communication link?

The steps involved in the wireless communication link are

- ✓ Source coding
- ✓ Channel coding
- ✓ Modulation
- ✓ Multiple accessing
- ✓ Transmission through radio channel

2. Draw the mathematical link for analysis of modulation scheme. (Nov 2011)

The mathematical link for analysis of modulation scheme is given below



3. What is linear modulation?

- ✓ In linear modulation technique, the amplitude of the transmitted signal varies linearly with the modulating digital signal.
- ✓ Linear modulation does not have a constant envelope.
- ✓ Ex. Pulse shaped QPSK, OQPSK, π/4QPSK

4. List the advantages of digital modulation techniques. (May 2015)

The advantages of digital modulation techniques includes

- ✓ Greater noise immunity
- ✓ Robustness to channel impairments
- ✓ Easier multiplexing of various forms of information.
- ✓ Greater security

5. Mention any two criteria for choosing a modulation technique for a specific wireless application. (May 2013)

Criteria for choosing a modulation technique for a specific wireless application are

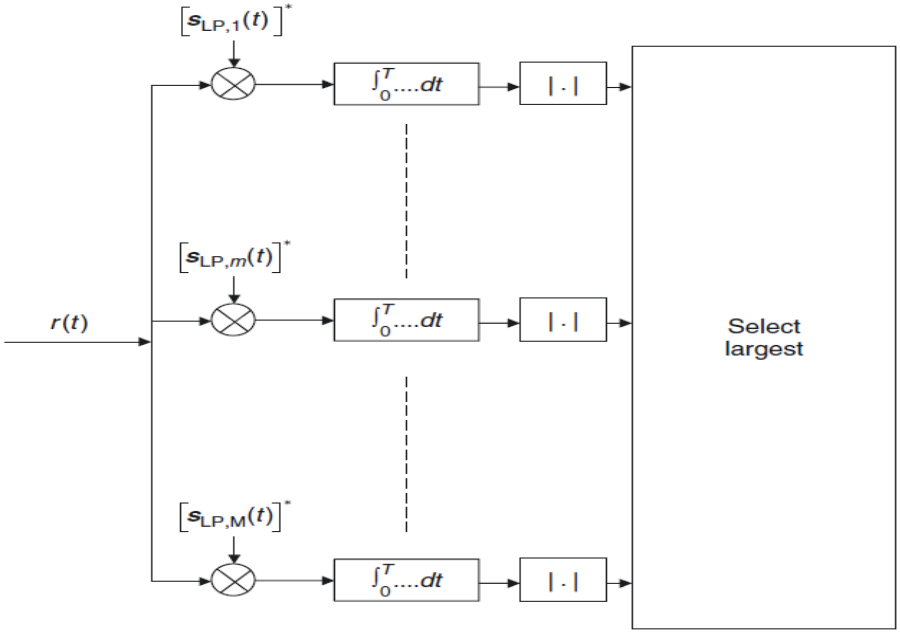
- ✓ Low BER at low received SNR.
  - i.e Bit-error rate performance
- ✓ Minimum bandwidth requirement.
  - i.e.Bandwidth efficiency
- ✓ Power efficiency
  - Adjacent channel interference must be small

- Power spectrum of the signal should show a strong roll-off outside the desired band.

✓ Spectral efficiency to be high.
✓ Better performance in multipath and fading conditions.
✓ Transmission of many data bits with each symbol
✓ Ease of implementation and low cost.

6. Draw the structure of generic optimum receiver. (May 2013)

The structure of generic optimum receiver is given below



7. What is OQPSK? (Nov 2011)

✓ To prevent the regeneration of sidelobes and spectral widening, it is imperative that QPSK signals be amplified only using linear amplifiers, which are less efficient.
✓ A modified form of QPSK, called offset QPSK (OQPSK) or staggered QPSK is less susceptible to these deleterious effects arid supports more efficient amplification.
✓ OQPSK signaling is represented by equation,

$$S_{OQPSK}(t) = \sqrt{\frac{2E_S}{T_S}}\cos\left[(i-1)\frac{\pi}{2}\right]\cos(2\pi f_c t) - \sqrt{\frac{2E_S}{T_S}}\sin\left[(i-1)\frac{\pi}{2}\right]\sin(2\pi f_c t)$$

8. Differentiate between OQPSK and QPSK.[April/May 2023]

OQPSK	QPSK
In OQPSK signaling, the even and odd bit streams, $m_I(t)$ and $m_Q(t)$ are offset in their relative alignment by one bit period	In QPSK signaling, the bit transitions of the even and odd bit streams occur at the same time instants.
OQPSK signals does not regenerate the high frequency side lobes	QPSK signals regenerate the high frequency side lobes.

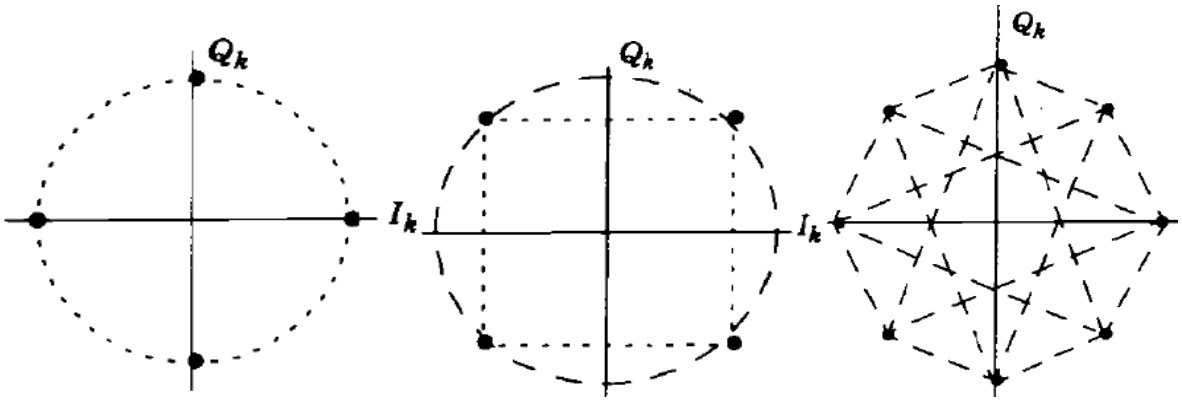
9. State the advantages of offset-QPSK. (Nov 2014)

List the features of offset- QPSK. [April/May 2019][Nov/Dec 2019]

The advantages of offset-QPSK includes

- ✓ Lower amplitude fluctuations.
- ✓ Suppress out-of-band interference.
- ✓ Limits the phase-shift to maximum of 90° at a time.
- ✓ Spectral occupancy is significantly reduced.
- ✓ More efficient RF amplification.
- ✓ Better performance in the presence of phase jitter due to noisy reference signals at the receiver

10. Draw the signal constellation and phase transition of $\pi/4$ QPSK signal.



(a) (b) (c)

(a) Possible States for θ_k when $\theta_{k-1} = \frac{n\pi}{4}$

(b) Possible States for θ_k when $\theta_{k-1} = \frac{n\pi}{2}$

(c) All Possible States

Figure: Constellation diagram of a $\frac{\pi}{4}$ QPSK signal

11. Differentiate offset QPSK and π/4 differential QPSK.

Offset QPSK	$\pi/4$ **DQPSK**
The amplitude of data pulses are kept constant. The time alignment of the even and odd bit streams are offset by one bit period in offset QPSK.	Signaling points of the modulated signal are selected from two QPSK constellations which are shifted by π/4 with respect to each other. It is differentially encoded and detected so called π/4 differential QPSK.

12. Define offset QPSK and π/4 differential QPSK. [Nov/Dec 2017]

The amplitude of data pulses are kept constant. The time alignment of the even and odd bit streams are offset by one bit period in offset QPSK.

Signaling points of the modulated signal are selected from two QPSK constellations which are shifted by π/4 with respect to each other. It is differentially encoded and detected so called π/4 differential QPSK.

13. What is meant by MSK?[Nov/Dec 2019]

- ✓ A continuous phase FSK signal with a deviation ratio of one half is referred to as MSK.
- ✓ MSK is a spectrally efficient modulation scheme.

14. Why is MSK referred to as fast FSK? (May 2016)

MSK is called as fast FSK since the frequency spacing used is only half as much as that used in convention al non-coherent FSK.

15. Mention the advantages of MSK over QPSK.

The advantages of MSK over QPSK are

- ✓ Output waveform is continuous in phase
- ✓ No abrupt changes in amplitude.
- ✓ Bandwidth requirement is less

16. Give the function of Gaussian filter in GMSK. (Nov 2016)

Comment on the necessity of a Gaussian filter in GMSK. (May 2015)

- ✓ Gaussian filters are used before the modulator to reduce the transmitted bandwidth of the signal.
- ✓ Gaussian filters use less bandwidth than conventional FSK.
- ✓ Gaussian filtering converts the full response message signal into a partial response scheme where each transmitted symbols pans several bit periods.

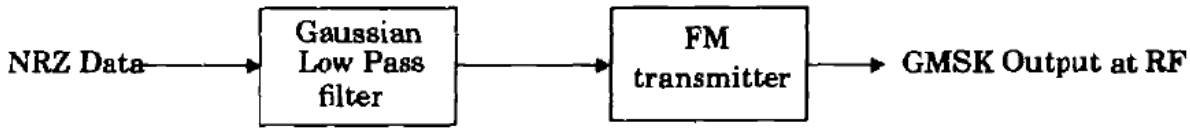
17. List the advantages of GMSK.

The advantages of GMSK are

- ✓ Improved spectral efficiency when compared to other phase shift keyed modes.
- ✓ Amplified by a non-linear amplifier and remain undistorted.
- ✓ Immune to amplitude variations
- ✓ More resilient to noise.
- ✓ Excellent power efficiency

18. How is GMSK generated?

ThesimplestwaytogenerateaGMSKsignalistopassaNRZmessagebitstreamthroughaGaussianbaseband filterfollowedbyanFMmodulator.



19. What do you mean by Non-Coherent detection? (Nov 2015)

When no phase information is required for detection, the type of detection is called non coherent detection.

20. How can we improve link performance?

Name the three techniques used to improve the received signal quality. [April/May 2019]

1. Diversity, 2. Equalization, 3. Channel coding

21. What is diversity, equalization technique?

- ✓ To reduce ISI, equalization technique is used.
- ✓ To reduce fading effects, diversity technique is used.

22. What is equalization, an equalizer? (Nov 2013)

What is the use of equalization technique? [Nov/Dec 2019][April/May 2023]

- ✓ The process of extracting the symbols from the received signal is called equalization.
- ✓ The goal of equalization is the combination of the transmitter; channel and receiver appear to be an all-pass channel. In the frequency domain equation

$H_{eq}(f)\, F*(-f) = 1$

Where $H_{eq}(f) \leftarrow F(f)$ are Fourier transforms of $h_{eq}(t) \leftarrow f(t)$ respectively.

$$\text{Equalizer transfer function} \propto \frac{1}{\text{Channel transfer function}}$$

Equalizer is a linear pulse shaping filter, used to reduce the dispersive effects of a channel like ISI- inter symbol interference is referred to as an ***equalizer***.

23. Write the major classifications of equalizers. State the significance of each. (May 2012, May 2013)[Nov /Dec 2019]

The major classification of equalization techniques is linear and nonlinear equalization.

Linear equalizer:

1. In linear equalizer, the current and past values of the received signal are linearly weighted by the filter coefficients and summed to produce the output. No feedback path is used.
2. Simple, easy to implement.
3. Not suitable for severely distorted channel, noise power signal is enhanced.

Non-linear equalizer:

1. If the past decisions are correct, then the ISI contributed by present symbol can be cancelled exactly, feedback path is used.
2. Suitable for severely distorted channel, also noise power is not enhanced.
3. Complex in structure, channels with low SNR, the DFE suffers from error propagation.

24. What are the types of non-linear equalizer?

It has three types

1. Decision feed back
2. Maximum likelihood symbol detector
3. Maximum likelihood sequence estimator

25. Write the advantages of lattice equalizer.

i. It is simplest and easily available.
ii. Numerical stability.
iii. Faster convergence.
iv. When the channel becomes more time dispersive, the length of the equalizer can be increased by the algorithm without stopping the operation.
v. Unique structure of the lattice filter allows the dynamic assignment.

26. Define adaptive equalization. Write the significance of it. (May 2016)

Adaptive equalizers assume channel is time varying channel and try to design equalizer filter whose filter coefficients are varying in time according to the change of channel, and try to eliminate ISI and additive noise at each time.

27. What are the applications of non linear equalizer? (May/June 2014)

Non linear equalizer is used for

- Microwave communications
- Satellite communications
- Mobile communications

28. Why is an adaptive equalizer required? (APRIL/MAY 2017)

In practice, the channel response is unknown.
Hence the optimum matched filter must be adaptively estimated to reduce error.

29. What are the applications of non linear equalizer? (May/June 2014)

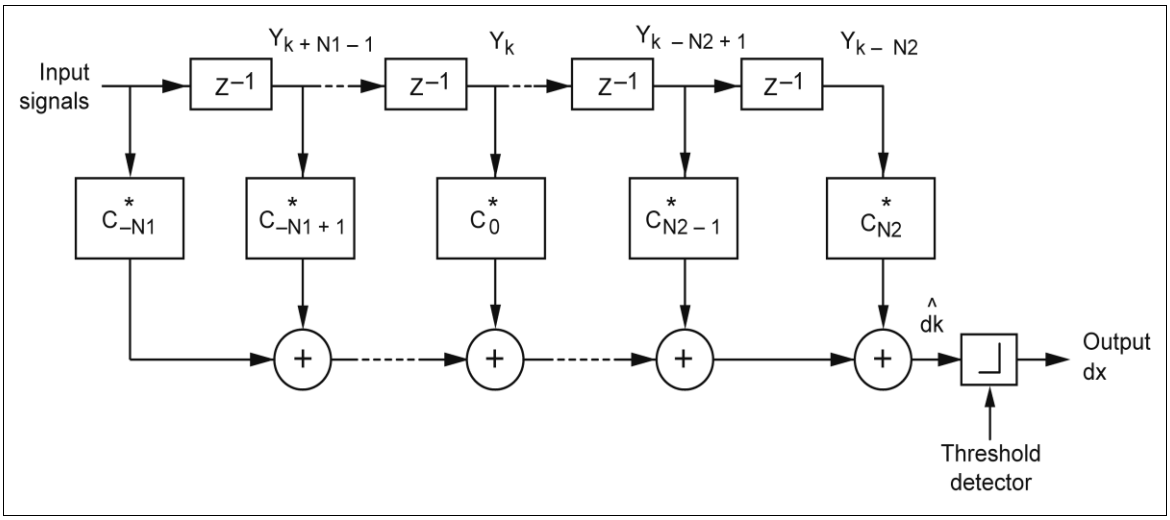
Non linear equalizer is used for i) Microwave communications ii) Satellite iii) Mobile communications.

30. What are the types of non-linear equalizer?

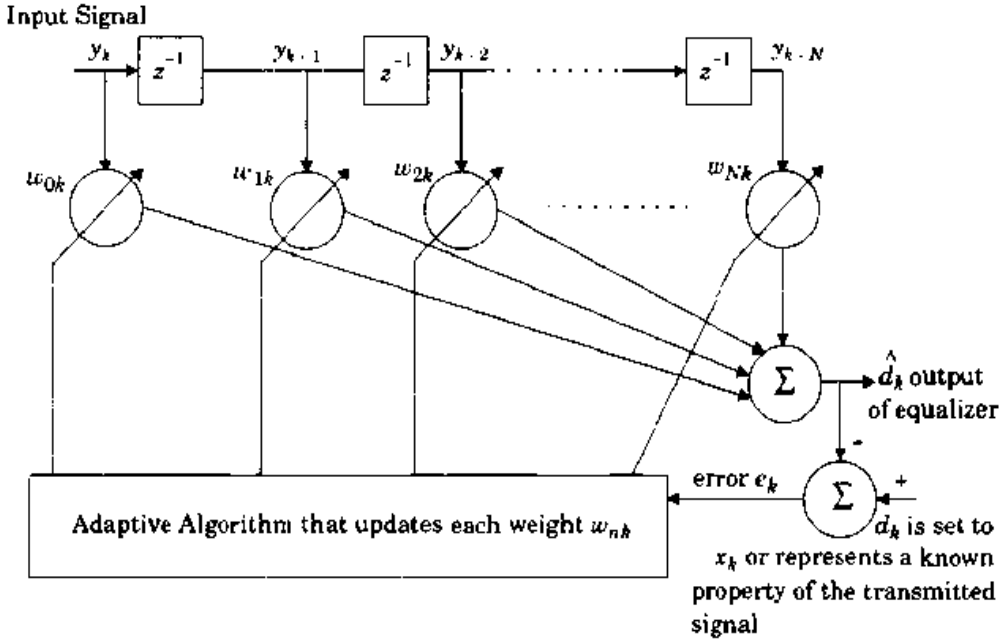
It has three types

1. Decision feed back
2. Maximum likelihood symbol detector
3. Maximum likelihood sequence estimator

31. Draw the structure of a linear transversal equalizer. (Nov/Dec 2015)



32. Draw the structure of generic optimum receiver. (May/June 2013)



33. Write about MLSE decision feedback equalizer. (May 2015)

- ✓ The MLSE is optimal in the sense that it minimizes the probability of a sequence error.
- ✓ The MLSE requires knowledge of the channel characteristics, noise in order to compute the metrics for making decisions.
- ✓ An MLSE usually has a large computational requirement, especially when the delay spread of the channel is large.

34. Write the advantages of MMSE equalizer.

Advantages of MMSE are

- ✓ The noise power of an MMSE equalizer is smaller than that of a ZF equalizer.
- ✓ Suitable for wireless link.

35. List the advantages and disadvantages of DFE equalizer.

Advantages of DFE are

- ✓ FBF can be realized as a lattice structure.
- ✓ RLS lattice algorithm can be used to yield fast convergence.
- ✓ DFE has a smaller error probability than a linear equalizer.

36. What are the factors used in adaptive algorithms?

i. Rate of convergence
ii. Misadjustment
iii. Computational complexity
iv. Numerical properties.

37. Write the basic algorithms used for adaptive equalizations.

(i) Zero forcing (ZF) algorithm.
(ii) Least mean squares (LMS) algorithm.
(iii) Recursive least square (RLS) algorithm.

38. Write the advantages drawbacks of RLS algorithm.

(i) Fast convergence

(ii) Good tracking ability. If smaller value of weighting coefficient L, the Equalizer has better tracking ability.

39. What are the differences between zero-forcing and mean squared error equalizer?[April/May 2019]

Zero Forcing Equalizer (ZF)	Mean Squared Error Equalizer (MSE)
1. Simple filters easy to implement as a transversal structure.	1. Optimum filter, implemented as a lattice structure.
2. It performs well for static channels with low SNR.	2. Suitable for static channels with high SNR.
3. Noise enhancement makes ZF equalizer not suitable for wireless link.	3. suitable for wireless link.

40. What is the principle of diversity technique? (May/June 2013, Nov/Dec 2013, Apr/May 2017)

- ✓ Signal is transmitted by more than one antenna via channel.
- ✓ It ensures that the same information reaches the receiver on statistically independent channels.

41. Why diversity technique is needed? Why it is employed? (Apr/May2017, Nov/Dec 2010)

In AWGN – channel, BER decreases exponentially as the SNR increases.

In Rayleigh fading channel – BER decreases linearly with SNR.

So, to achieve 10^{-4} BER, diversity is used.

42. Define SNR.

SNR = average received signal energy per (complex) symbol time/ noise energy per (complex) symbol time

43. What is small scale fading, large scale fading?

Small scale fading	Large scale fading
• Due to multiple reflections from the surroundings, small scale fading occur over a short period of time or travel distance. • It causes deep and rapid amplitude fluctuations in the signal.	• Due to shadowing of large terrain profile large scale fading occurs. • It causes variations in the signal strength.

44. Define 5 common methods of micro diversity. (Nov 2011)[Nov/Dec 2017]

The five most common methods are

1. Spatial diversity → several antenna elements separated in space.
2. Temporal diversity → Repetition of the transmit signal at different times.
3. Frequency diversity → Transmission of the signal on different frequencies.
4. Angular diversity → Multiple antennas with different antenna patterns.
5. Polarization → Multiple antennas receiving different polarizations

45. Define space diversity/ antenna diversity and its types. (May 2010, Nov/Dec 2015)

Space diversity is also known as antenna diversity. The concept is at each cell site, multiple base station receiving antennas are used to provide diversity reception.

Space diversity reception methods can be classified into two categories

1. Selection diversity---- a) switched diversity b) Feedback diversity
2. Combining diversity ----a) Maximal ratio combining b) Equal gain diversity

46. Differentiate selection and combining diversity.

S.No.	Selection diversity	Combining diversity
1.	The "best signal" copy is selected and processed while all other copies are discarded. *e.g.* large RSSI – received signal strength indication is selected.	Combining diversity:- All copies of the signal are combined before (demodulation) processing and the combined signals are decoded.
2.	Simple circuits are needed.	Individual receiver phasing circuits are needed.
3.	None of the signal is not in acceptable SNR means, it is degraded.	It works better than selection diversity.

47. Write the classification in signal combining techniques.

1. Selection diversity---- Fading path with highest gain used to select best signal
   a) switched diversity----active branch is monitored continuously
   b) Feedback diversity ---- scanned in a fixed sequence
2. Combining diversity ---- All copies of the signal are combined before processing
   a) Maximal ratio combining --- The signals from all of the M branches are weighted according to their SNR and then summed
   b) Equal gain combining ------ The branch weights are all set to unity but the signals from each are co-phased to provide equal gain combining diversity

48. Compare MRC and EGC techniques.

MRC- Maximal ratio combining	EGC- Equal gain combining
The signals from all of the M branches are weighted according to their SNR and then summed.	The branch weights are all set to unity but the signals from each are co-phased to provide equal gain combining diversity.

49. Define Polarization diversity.

In TX side, two diversity branches are used. Signals are transmitted through two orthogonally polarized propagation path.

In RX side, antennas with two elements receive the vertical or horizontally polarized signal.

In the channel, if the signal is obstructed, polarization diversity will reduce the multipath spread without decreasing the receiver power.

50. Differentiate between Micro, Macro diversity. (May 2014, Nov 2014) [Nov/Dec 2019]

What do you mean by micro and macro diversity? [April/May 2019]

S.No.	Micro diversity	Macro diversity
1.	Used to reduce small scale fading effects.	Used to reduce large scale fading effects.
2.	Multiple reflections cause deep fading. This effect is reduced.	Deep shadow causes fading. This effect is reduced.
3.	BS – MS are separated by a small distance.	BS – MS are separated by a large distance.

51. What is transmit diversity? (Nov/Dec 2017, Apr/May 2015, Nov/Dec 2015)

Diversity effect is achieved by transmitting signals from several transmit antenna is known as transmit diversity.

52. What is receiving diversity (or) diversity reception technique? (Nov/Dec 2017, Apr/May 2015, Nov/Dec 2015, Nov/Dec 2012)

Diversity effect is achieved by receiving signals from several receive antenna is known as receive diversity.

53. What is the basic idea of Rake receiver. (Nov 2012)

- ✓ It consists of a bank of correlators; each sampled at a different time with delay τ and thus collects energy from the MPC.
- ✓ The sample values from the correlators are then weighted and combined to achieve improved communications reliability and performance.
- ✓ The tap delays as well as the tap weights are adjustable and matched to the channel.

54. What are the benefits of RAKE receiver? (May 2016)

The main advantage of Rake Receiver is that it improves the SNR (or) E_b / N_o. Naturally, this improvement is observed in larger environments with many multipaths than in environments without obstruction.

55. What do you mean by coding gain? (Nov/Dec 16)

Coding gain is what allows a channel error rate of 10^{-2} to support decoded data rates which are 10^{-5} or better.

56. Distinguish between Diversity gain and array/ Beam forming gain.[April/May 2018]

Diversity gain reflects the fact that it is improbable that several antenna elements are in a fading dip simultaneously. Thus probability of error is very low.

Beam forming gain reflects the fact that the combiner performs an averaging over the noise at different antennas.

Thus, even if the signal levels at all antenna elements are identical, the combined output SNR is larger than the SNR at a single antenna element.

57. List out the factors that influence the performance of adaptive equalization algorithms. [April/May 2021]

- **Rate of convergence**This is defined as the number of iterations required for the algorithm, in response to stationary inputs, to converge close enough to the optimum solution.A fast rate of convergence allows the algorithm to adapt rapidly to a stationary environment of unknown statistics.
- **Misadjustment:** This parameter provides a quantitative measure of the amount by which the final value of the mean square error, averaged over an ensemble of adaptive filters, deviates from the optimal minimum mean square error.
- **Computational complexity:**This is the number of operations required to make one complete iteration of the algorithm

- **Numerical properties:**When an algorithm is implemented numerically, inaccuracies are produced due to round-oft' noise and representation errors in the computer.These kinds of errors influence the stability of the algorithm.

58. Assume 5 branch diversity is used, where each branch receives an independent Rayleigh fading signal . If the average SNR is 20 dB, determine the probability that the SNR will drop below 10 dB. [April/May 2021]

For this example the specified threshold $\gamma = 10$ dB, $\Gamma = 20$ dB, and there are four branches. Thus $\gamma/\Gamma = 0.1$ and using equation (6.58),

$$P_4(10\text{ dB}) = (1 - e^{-0.1})^4 = 0.000082$$

When diversity is not used, equation (6.58) may be evaluated using $M = 1$.

$$P_1(10\text{ dB}) = (1 - e^{-0.1})^1 = 0.095$$

Notice that without diversity the *SNR* drops below the specified threshold with a probability that is three orders of magnitude greater than if four branch diversity is used!

59. How equalization is achieved through zero forcing algorithm? [Nov/Dec 2021]

The zero forcing equalizer applies the inverse of the channel frequency to the received signal, to restore the signal after the channel. The name zero forcing corresponds to bringing down the intersymbol interference to zero in a noise free case.

60. How error probability is computed for fading channel in SISO system? [Nov/Dec 2021]

Fading can cause poor performance in a communication system because it can result in a loss of signal power without reducing the power of the noise. This signal loss can be over some or all of the signal bandwidth.

61. What is the error performance degradation in communication system? [April/May 2023]

The main causes of error performance degradation are interference electrical noise effect of filtering and due to the surroundings. The motion of thermal electrons causes degradation causes thermal noise, which cannot be eliminated, in system.

****

UNIT – III

MODULATION TECHNIQUES AND EQUALIZATION AND DIVERSITY

QUESTION BANK

PART – A

1. What are the steps involved in the wireless communication link?
2. Draw the mathematical link for analysis of modulation scheme.
3. Mention any two criteria for choosing a modulation technique for a specific wireless application.
4. Draw the structure of generic optimum receiver.
5. Differentiate between OQPSK and QPSK.
6. State the advantages of offset-QPSK.
7. Draw the signal constellation and phase transition of $\pi/4$ QPSK signal.
8. Define offset QPSK and $\pi/4$ differential QPSK.
9. Why is MSK referred to as fast FSK?
10. Give the function of Gaussian filter in GMSK.
11. What is equalization, an equalizer?
12. Write the major classifications of equalizers. State the significance of each.
13. Why is an adaptive equalizer required?
14. What are the types of non-linear equalizer?
15. Draw the structure of a linear transversal equalizer.

PART – B & C

1. Explain the factors that influence the choice of Digital Modulation.
2. Explain in detail about Binary Phase Shift Keying (BPSK).
3. Explain in detail about Differential Phase Shift Keying (DPSK).
4. Explain in detail about Quadrature Phase Shift Keying (QPSK).
5. Explain in detail Offset QPSK linear digital modulation techniques employed in wireless communication.
6. With neat diagram, explain the modulation and demodulation of $\pi / 4$ DQPSK modulation techniques.
7. What is MSK? Also derive the expression of MSK signal as a special type of FSK signal and explain its spectral density.
8. Explain in detail Gaussian Minimum shift Keying (GMSK) transmission and reception with necessary diagrams.
9. Explain about Spread Spectrum Modulation Techniques.
10. Explain about equalization and Draw and explain a simplified communication system using an adaptive equalizer at the receiver.
11. Analyze various diversity techniques used in wireless communication.
12. Explain in detail about Practical Space Diversity Considerations.
13. Explain with diagram, the different techniques available for signal combining.

******

UNIT- IV

MULTIPLE ACCESS TECHNIQUES

TWO MARKS

1. What is multiple access technique? [May 2016, Nov 2013, May2023]

Multiple access or channel access method is based on a multiplexing method that allows several data streams or signals to share the same communication channel or physical medium.

2. Write the applications of multiple access methods.

- The multiple access methods are used in
  - ✓ Satellite networks
  - ✓ Cellular and mobile communication networks
  - ✓ Military communication and
  - ✓ Underwater acoustic networks.

3. What are the different types of multiple access schemes? [May 2012]

The different types of multiple access schemes are

- Frequency Division Multiple Access (FDMA)
- Time Division Multiple Access (TDMA)
- Code Division Multiple Access (CDMA)

4. State the difference between Narrowband and wideband systems. [Nov 2013, Nov 2012]

NARROWBAND SYSTEMS	WIDEBAND SYSTEMS
In a narrowband system, the available radio spectrum is divided into a large number of narrowband channels.	In wideband system, a large number of transmitters are allowed to transmit on the same channels.

5. Define FDMA.

In FDMA, the total bandwidth is divided into non-overlapping frequency sub bands. Each user is allocated a unique frequency sub band (channels) for the duration of the connection, whether the connection is in an active or idle state.

6. What is the need of guard bands in FDMA?

The adjacent frequency bands in the FDMA spectrum are likely to interference with each other. Therefore it is necessary to include the guard bands between the adjacent frequency bands.

7. Mention some features of FDMA.[Nov/Dec 2019]

- ✓ FDMA is relatively simple to implement.
- ✓ To provide interference-free transmissions between the uplink and the downlink channels, the frequency allocations have to be separated by a sufficient amount (guard bands).

8. Write the nonlinear effects in FDMA.

- ✓ In FDMA system, many channels share same antenna at the base station. The power amplifiers and the power combiners used are nonlinear, and tend to generate inter modulation frequencies resulting in inter modulation distortion.

9. Write the expression for number of channels used in FDMA system.

- ✓ The number of channels that can be simultaneously supported in a FDMA system is given by

$$N_S = \frac{B_s - 2B_g}{B_c}$$

Where, B_s-Total spectrum allocation (or) system bandwidth
B_g-Guard band allocated at the edge of the allocated spectrum band and
B_g-Channel bandwidth

10. Write the formula for spectral efficiency of FDMA.

- ✓ The spectral efficiency of FDMA is given by

$$\eta_{FDMA} = \frac{bandwidthavailablefordatatransmission}{systembandwidth}$$

$$\eta_{FDMA} = \frac{N_{data}B_c}{B_s} < 1$$

Where N_{data}=Number of data channels in the system.
$N_{data} = N_S$-N_{ctl}
N_{ctl} = Number of allocated control channels

11. Mention the disadvantages of FDMA.

- ✓ This type of multiple access support is narrow band, and is not suitable for multimedia communications with various transmission rates.
- ✓ If a FDMA channel is not in use, then it is idle and cannot be used by other users to increase or share capacity. It is essentially a wasted resource.
- ✓ FDMA is an old and is used for the analog signal.

12. Define TDMA.

- ✓ Time Division Multiple Access (TDMA) systems divide the ratio spectrum into time slots, and in each slot only one user is allowed to either transmit or receive.

13. What is W- TDMA?

- ✓ In wideband TDMA, transmission in each slot uses the entire frequency band.

14. Define N- TDMA.

- ✓ In narrow band TDMA, the whole frequency band is divided into sub band, transmission in each slot only uses the frequency width of one sub band.

15. Write the features of TDMA.

- ✓ TDMA shares a single carrier frequency with several users, where each user makes use of non-overlapping time slots.
- ✓ Data transmission for users of a TDMA system is not continuous, but occurs in bursts. This results in low battery consumption, since the subscriber transmitter can be turned off when not in use.
- ✓ Because of discontinues transmissions in TDMA, the handoff process is much simpler for a subscriber unit, since it is able to listen for other base stations during idle time slots.

16. What is frame efficiency in TDMA?

- ✓ The frame efficiency is the ***percentage***of bits per frame which contain transmitted data.
The frame efficiency is given by

$$\eta_{f=\left(1-\frac{b_{OH}}{b_T}\right)\times 100\%}$$

b_{OH} = Number of overhead bits per frame and
b_T = Number of total bits per frame

17. What are the disadvantages of TDMA?[Nov/Dec 2019]

- ✓ High synchronization overhead is required in TDMA systems because of burst transmissions.
- ✓ In TDMA, the guard time should be minimized.

18. How does near/far problem influence TDMA systems? [Nov 2015]

The near-far problem is one of detecting or filtering out a weaker signal amongst stronger signals. The near-far problem is particularly difficult in CDMA systems where transmitters share transmission frequencies and transmission time. In contrast, FDMA and TDMA systems are less vulnerable

19. State advantages of CDMA over FDMA. [Nov 2014]

CDMA sends digital signals spread out over a larger bandwidth constantly with each signal having a unique sequence code so that each call can be separated at the receiver. In theory, CDMA can carry 8-10 times the number of calls as FDMA, although probably not nearly that many times in the real world.

20. Define near-far problem in CDMA.

- ✓ Some of the mobile units are close to the base station while others are far from it. A strong signal received at the base from a near –in mobile unit and the weak signal from a far –end mobile unit. This phenomenon is called the near-far problem.

21. Write some features of CDMA.

- ✓ Many user of CDMA system share the same frequency.
- ✓ Channel data rates are very high in CDMA system.
- ✓ CDMA has more flexibility than TDMA in supporting multimedia service.

22. How FDMA handles near-far problem?[April/May 2019]

The near-far problem is one of detecting or filtering out a weaker signal amongst stronger signals. The near-far problem is particularly difficult in FDMA systems where transmitters share transmission frequencies and transmission time.

23. Differentiate between FDMA, TDMA and CDMA technologies.[April/May 2018]

S.N	FDMA	TDMA	CDMA
1	Channel bandwidth is subdivided into number of sub channels	The radio spectrum is divided into time slots and each slot is allotted for only one user who can either transmit or receive.	Sharing of bandwidth and time takes place.
2	FDMA uses Narrow band Systems.	TDMA uses Narrow band Systems or wide band Systems	CDMA uses Wide band Systems.
3	FDMA is First generation wireless standard (1G).	TDMA is Second generation wireless standard (2G).	CDMA is third generation wireless standard (3G).
4	FDMA is use for the voice and data transmission	TDMA is used for data and digital voice signals	CDMA is use for digital voice signals and multimedia services.
5	Due to non-linearity of power amplifiers, inter-modulation products are generated due to interference between adjacent channels.	Due to incorrect synchronization there can be interference between the adjacent time slots.	Both type of interference will be present.
6	Synchronization is not necessary	Synchronization is necessary	Synchronization is not necessary
7	Code word is not required	Code word is not required	Code words are required
8	Guard bands between adjacent channels are necessary.	Guard times between adjacent time slots are necessary.	Guard bands and guard times are necessary.

******

UNIT- IV

MULTIPLE ACCESS TECHNIQUES

QUESTION BANK

PART – A

1. What is multiple access technique?
2. What are the different types of multiple access schemes?
3. State the difference between Narrowband and wideband systems.
4. Mention some features of FDMA.
5. Define FDMA.
6. What is the need of guard bands in FDMA?
7. Mention some features of FDMA.
8. Write the nonlinear effects in FDMA.
9. Write the expression for number of channels used in FDMA system.
10. Write the formula for spectral efficiency of FDMA.
11. Mention the disadvantages of FDMA.
12. Define TDMA.
13. Write the features of TDMA.
14. What are the disadvantages of TDMA?
15. How does near/far problem influence TDMA systems?
16. State advantages of CDMA over FDMA.
17. How FDMA handles near-far problem?
18. Differentiate between FDMA, TDMA and CDMA technologies.

PART – B & C

1. Summarize the features of various multiple access techniques used in wireless mobile communication. State the advantages and disadvantages of each technique.
2. Explain any one type of multiple access schemes.
3. Explain TDMA and discuss the time division multiple access frame structure.
4. Explain in detail about spread spectrum multiple access.
5. What are the major difference between TDMA, FDMA and CDMA? Explain in detail about each multiple access.
6. Explain in detail about space division multiple access (SDMA).
7. Explain in detail about Capacity of Cellular Systems.
8. Explain the capacity of cellular CDMA.
9. Explain about Capacity Of CDMA With Multiple Cells.

******

UNIT- V
WIRELESS NETWORKING
TWO MARKS

1. What is meant by wireless networking?

Wireless Networking: A mobile network (also wireless network) route's communications in the form of radio waves to and from users. It is composed of base stations that each cover a delimited area or "cell." When joined together these cells provide radio coverage over a wide geographic area.

2. Write about mobile switching center.

The *base stations must be connected to* ***a central hub*** called the ***Mobile Switching Center (MSC)***. The MSC *provides connectivity between* the ***public switched telephone network (PSTN)*** and the ***numerous base stations***, and ***between all of the wireless subscribers*** in a system.

3. What are the functions of common air interface (CAI).

- To connect mobile subscribers to the base stations, ***radio links*** are established using ***communication protocol*** called ***common air interface (CAI)***.
- It is a precisely defined ***handshake communication protocol***.
- The *common air interface* specifies how ***mobile subscribers and base stations communicate*** over radio frequencies.
- CAI also defines the ***control channel signaling methods***.

4. Differentiate Wireless And Fixed Telephone Networks.

Sl. No.	Fixed Telephone Network	Wireless Telephone Network
1.	The transmitter and receiver is fixed at one place. Information is carried over cables(fiber optic/copper) and fixed links(microwave/satellite)	The transmitter and receiver communicate via EM radio waves. They are not always fixed at one place but can move also.
2.	A telephone Central office takes care of millions of landline telephone connections.	MSCs take care of cellular telephone connections based on air traffic capacity.
3.	Less overhead data needed.	More overhead data needed as geographical location keeps changing.

5. Write about as interexchange carriers.

- A *long distance telephone company* ***collects toll fees*** to provide connections between different LATAs (interLATA) over its long distance network.
- These companies are referred to as ***interexchange carriers (IXC)***.
- IXCs ***own and operate*** large *fiber optic and microwave radio networks*.
- IXCs are connected to LECs (***local exchange carriers***) throughout a country or continent.

6. Write the functions of MSCs in first generation wireless networks.

- T In first generation cellular networks, the system control for each market resides in the MSC.
- The MSC maintains all mobile related information and controls each mobile hand-off.
- The ***MSC*** also ***performs all of the network management functions***, such as call handling and processing, billing, and fraud detection within the market.

7. What is interoperator roaming?

Until the early 1990s, U.S. cellular customers that roamed between different cellular systems had to register manually each time they entered a new market during long distance travel. This required the ***user to call an operator to request registration***.

8. Give some examples of second generation wireless systems?

Examples of second generation wireless systems include

a. the *Global System for Mobile (GSM),*
b. the *TDMA and CDMA U.S. digital standards* (IS-54 and IS-95 standards),
c. Second Generation *Cordless Telephone (CT2),*
d. the British standard for cordless telephony,
e. the *Personal Access Communications System (PACS) local loop standard*, and
f. Digital European Cordless Telephone (DECT).

9. What are the functions handled by second generation wireless systems?

Second generation wireless networks have been specifically designed to ***provide paging, and other data services such as facsimile and high-data rate network access***.

10. What are the aims of third generation wireless networks?

The aim of third generation wireless networks is

a. to provide a single set of standards that can meet a wide range of wireless applications, and
b. to provide universal access throughout the world.

11. Write about third generation wireless networks.

The third generation wireless systems, ***universal personal communicator*** *(a personal handset)* will ***provide access*** to ***a variety of voice, data, and video communication services***.

12. Write about DS formats used in US.

DS format in the U.S.

- **DS-0**: It represents ***one duplex voice channel*** which is ***digitized into a 64 kbps binary PCM format***.
- **DS-1**: It represents ***twenty four full duplex DS-0 voice channels*** that are ***time division multiplexed into a 1.544 Mbps data stream*** (8 kbps is used for control purposes).

13. What are the routing services provided by networks?

- Two general ***routing services*** are provided by networks.
- These are
  a. ***connection-oriented services*** (virtual circuit routing), and
  b. ***connectionless services*** (datagram services).

14. What is connection oriented routing?

In connection-oriented routing,

a. the communications ***path*** between the message source and destination ***is fixed*** for the entire duration of the message, and
b. a call set-up procedure is required to dedicate network resources to both the called and calling parties.

15. What is connectionless routing?

In Connectionless routing,

- it ***does not establish a firm (fixed) connection*** for the traffic.
- it relies on packet-based transmissions.
- Several ***packets form a message***, and each ***individual packet is routed separately***.

16. Write about packet information overhead.

The ***Packet overhead*** *information* includes

a. the packet source address,
b. the destination address,
c. the routing information, and
d. information needed to properly order packets at the receiver.

17. What is meant circuit switching?

Circuit switching is a type of network configuration in which a physical path is obtained and dedicated to a single connection between two endpoints in the network for the duration of a dedicated connection.

18. What is meant packet switching?

- **Packet Switching** transmits data across digital networks by breaking it down into blocks or packets for more efficient transfer using various network devices.
- Each time one device sends a file to another, it breaks the file down into packets so that it can determine the most efficient route for sending the data across the network at that time.
- The network devices can then route the packets to the destination where the receiving device reassembles them for use.

19. Differentiate circuit switching and packet switching.

Sl. No.	Circuit Switching	Packet switching
1.	In circuit switching has there are 3 phases: i) Connection Establishment. ii) Data Transfer. iii) Connection Released.	In Packet switching directly data transfer takes place.
2.	In-circuit switching, each data unit knows the entire path address which is provided by the source.	In Packet switching, each data unit just knows the final destination address intermediate path is decided by the routers.
3.	In-Circuit switching, data is processed at the source system only	In Packet switching, data is processed at all intermediate nodes including the source system.
4.	The delay between data units in circuit switching is uniform.	The delay between data units in packet switching is not uniform.
5.	Resource reservation is the feature of circuit switching because the path is fixed for data transmission.	There is no resource reservation because bandwidth is shared among users.

20. What are the five fields of transmitted packet in packet switching?

The transmitted packet typically consists of five fields:

- ✓ the flag bits,
- ✓ the address field,
- ✓ the control field,
- ✓ the information field, and
- ✓ the frame check sequence field.

21. What are the advantages of packet switching?

Advantages:

- ✓ Packet switching (or 'packet radio' in wireless link) provides ***excellent channel efficiency*** for bursty data transmissions of short length.
- ✓ The channel is utilized only when sending or receiving ***bursts of information***.
  - This benefit is valuable in *mobile services where the available band width is limited*.
- ✓ It can provide highly reliable transfer in degraded channel conditions.

22. What are the aims of personal communication systems (PCS)?

The objective of personal communication systems (PCS) or personal communication networks (PCNs) is to

- ✓ provide ubiquitous *(Universal)* wireless communications coverage,
- ✓ enabling users to access the telephone network for different types of communication needs (regardless of the location of the user or the location of the information being accessed).

23. What are the architectural levels of Personal Communication Services?

- ➢ **Intelligent level** contains
  - i. databases for the storage of information about the network users,
- ➢ **Transport level**
  - i. handles the transmission of information.
- ➢ **Access level**
  - i. It provides ubiquitous access to every user in the network
  - ii. Also, contains databases that update the location of each user in the network.

24. What are the key elements of Cellular Packet Switched architecture?

Key elements in the network that facilitate transfer of information are

a. base station interface unit (BIU),
b. cellular controller interface unit (CIU),
c. trunk interface unit (TIU), and
d. each subscriber's wireless interface unit (WIU).

25. What is base station interface unit?

- ➢ The BIU ***provides information exchange*** between the TIUs and the WIUs.
- ➢ The BIU also ***broadcasts packets*** for providing feedback to the PRMA protocol.
- ➢ The BIU is ***addressed by its permanent address*** in the packet header.
- o The major function of the BIU is ***to relay packets to either the WIU or the TIU*** using the ***virtual circuit identifiers*** of the incoming packets

26. What is Packet Reservation Multiple Access (PRMA)?

- PRMA is a derivative of reservation ALOHA, which is a combination of TDMA and slotted ALOHA.
- A ***reservation protocol*** like PRMA has an advantage in that *it can utilize the discontinuous nature of speech* with the help of a voice activity detector (VAD) to increase capacity of the radio channel.

27. What is UMTS?

Universal Mobile Telecommunications Service (UMTS) refers to a group of radio technologies associated with the third generation of cellular networks (3G). Compared to its predecessors, UMTS made it possible to deploy a wider range of data-intensive IoT applications.

28. What is network reliability in UMTS?

\Network Reachability:

a. The network maintains a constant location information on each of the terminals.
b. The location will be updated by a terminal whenever it changes a location area.
c. The network will also take advantage of a distributed network database, for routing of calls once the exact location of the mobile has been accessed.

*****

UNIT- V
WIRELESS NETWORKING

QUESTION BANK

PART – A

1. Write about mobile switching center.
2. Differentiate Wireless And Fixed Telephone Networks.
3. Write about as interexchange carriers.
4. Write the functions of MSCs in first generation wireless networks.
5. What is interoperator roaming?
6. Give some examples of second generation wireless systems?
7. What are the functions handled by second generation wireless systems?
8. What are the aims of third generation wireless networks?
9. Write about third generation wireless networks.
10. What are the routing services provided by networks? What is connection oriented routing?
11. What is meant packet switching?
12. Differentiate circuit switching and packet switching.
13. What are the five fields of transmitted packet in packet switching? What are the advantages of packet switching?
14. What is Packet Reservation Multiple Access (PRMA)?
15. What is UMTS?

PART – B & C

1. Give a brief discussion on wireless networks.
2. Discuss the differences Between Wireless and Fixed Telephone Networks.
3. **Illustrate the Public Switched Telephone Network with relevant architectural diagrams.**
4. **Explain the development of wireless networks through the first, second and third generations.**
5. Explain in detail about Fixed Network Transmission Hierarchy.
6. Explain the mechanism of traffic routing in wireless networks with routing services.
7. **Explain the concepts of circuit and packet switching in Traffic Routing In Wireless Networks.**
8. Explain the Personal Communication Services / Networks.
9. **With neat diagram explain Cellular Packet - Switched Architecture.**
10. Discuss about Network Functionality in Cellular Packet-Switched Architecture.
11. Explain in detail about Packet Reservation Multiple Access (PRMA).
12. Write short notes on network databases with Distributed Database for Mobility Management.
13. **Draw and explain the Network architecture Universal Mobile Telecommunication Systems (UMTS).**

******