**RMD ENGINEERING COLLEGE**
**DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING**
**EC8652 – WIRELESS COMMUNICATION**
**QUESTION BANK**

## UNIT-I WIRELESS CHANNELS

### PART-A

**1. Define Far field or Fraunhoffer region.**

The far-field, or Fraunhofer region, of a transmitting antenna is defined as the region beyond the farfield distance $d_f$, which is related to the largest linear dimension of the transmitter antenna aperture and the carrier wavelength. The Fraunhofer distance is given by $df = \frac{2D^2}{\lambda}$ where D is the largest physical linear dimension of the antenna.

Additionally, to be in the far-field region, $d_f$ must satisfy $d_f >> D$ and $d_f >> \lambda$

**2. Define Doppler Shift.**

Due to the relative motion between the mobile and the base station, each multipath wave experiences an apparent shift in frequency. The shift in received signal frequency due to motion is called the Doppler shift, and is directly proportional to the velocity and direction of motion of the mobile with respect to the direction of arrival of the received multipath wave.

Apparent change in frequency, or Doppler shift, is given by $f_d$ where

Doppler shift $f_d = \frac{1}{2\Pi}\frac{\Delta\phi}{\Delta t}$ or $f_d = \frac{v}{\lambda}\cos\theta$

**3. Define mean excess delay.**

The mean excess delay is the first moment of the power delay profile and is defined as

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

4. **Define Coherence Bandwidth.**

Coherence Bandwidth is a statistical measure of the range of frequencies over which the channel can be considered flat (i.e., a channel which passes all spectral components with approximately equal gain and linear phase). In other words, coherence bandwidth is the range of frequencies over which two frequency components have a strong potential for amplitude correlation.

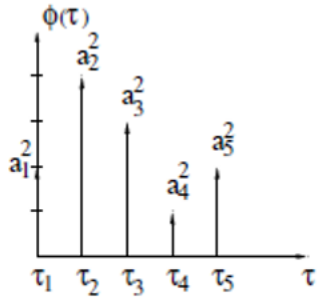
$$B_c \approx \frac{1}{50\sigma_\tau} \quad \text{or} \quad B_c \approx \frac{1}{5\sigma_\tau}$$

where, $\sigma_\tau$ → rms delay spread

**5. Define Power delay profile.**

Power delay profiles are generally represented as plots of relative received power ($a_k^2$) as a function of excess delay (τ) with respect to a fixed time delay reference. Power delay profiles are found by

averaging instantaneous power delay profile measurements over a local area in order to determine an average small-scale power delay profile.




Multipath Power Delay Profile

**6. Define Brewster Angle**

Brewster angle is defined as the angle at which no reflection occurs. It is denoted by $\theta_B$

$$\text{Sin } \theta_B = \text{sqrt } (\varepsilon_1/\varepsilon_1+\varepsilon_2)$$

**7. State Huygen's principle of diffraction.**

All points on a wave front can be considered as point sources for the production of secondary wavelets and these wavelets combine to form a new wavefront in the direction of propagation.

**8. What are the three effects of small scale multipath propagation?**

a. Rapid changes in signal strength over a small distance

b. Random frequency modulation due to Doppler shift.

c. Time dispersion caused by multipath propagation delays

**9. Define EIRP.**

EIRP of a transmitting system in a given direction as the transmitter power that would be needed, with an isotropic radiator, to produce the same power density in the given direction

EIRP=$P_tG_t$

Where $P_t$-transmitted power in w

$G_t$-transmitting antenna gain

**10. Explain path loss?**

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

**PART-B**

1. a. What you mean by path loss model? Explain large scale path loss,

   b).Define propagation model and, explain the two types of propagation model?

2. Explain the free space path loss model, and describe the following

   a).log-distance path loss model,

   b).log-normal shading path loss model

   c). determination of percentage of coverage area 3. 3.

Explain following

a). Explain friis free space equation. b). Explain $d^{-4}$ law?

c). Explain path loss equation for a free space propagation model.

4. Derive the expression for electric field, path loss and received power for a Two Ray model?
5. a). Explain small scale fading and, what are the factors affecting the small scale fading.

   b).a mobile is located at 5Kms away from base station and uses a vertical λ/4 monopole antenna with a gain of 2.55 dB to receive cellular radio signals. The E- field at 1Km from transmitter is measured to $10^{-3}$V/m the carrier frequency is 900MHz.Find the length and effective aperture of the effective the receiving antenna
6. a. Explain power delay profile, mean excess delay , RMS delay spread & Maximum excess delay.

   b. calculate mean excess delay , RMS delay spread & maximum excess delay for the figure given below . Also estimate the coherence bandwidth of the channel.

| Time in micro seconds | power in dB |
|---|---|
| 0 | -20 |
| 1 | -10 |
| 2 | -10 |
| 5 | 0 |

7. Explain the following

   a. Doppler shift b. Doppler spread c. Coherence time
8. Explain fading due to multipath delay spread?
9. Explain fading due to Doppler spread and coherence time?
10. Define small scale fading, write the detail of following small scale fading

    a).Time dispersion parameter

    b). Coherence band width
11. Compute the rms delay spread for the following delay profile

| Time in micro seconds | power |
|---|---|
| 0 | 1 |
| 1 | 1 |
| 2 | 1 |

a. Calculate the rms delay spread for the figure.

b. IF BPSK modulation is used , what is the maximum bit rate that can be sent through the channel without needing an equalizer ?

## UNIT-II Cellular Architecture

## PART-A

**1. What is frequency reuse?**

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. The actual radio coverage of a cell is known as the footprint and is determined from field measurements or propagation prediction models.

**2. Define Handoff.**

Handoff or handover is the term refers to transfer of mobile connection from one resource (Base Station) to another without disconnecting the voice or data call. When a mobile moves into a different cell while a conversation is in progress, the MSC automatically transfers the call to a new channel belonging to the new base station.

**3. Differentiate between hard and soft handoff.**

Hard handoff (break before make) - In this type, connection with the source channel/Base Station is first broken making connection with target channel/Base station

Soft handoff (make before break). - In this type, connection with the source channel/Base Station is retained for sometime before connection with target channel/Base station is established. The user will not experience any glitch and will continue to receive better service

**4. Define Co-channel reuse ratio.**

Co-channel reuse ratio,

$Q=D/R=\sqrt{3N}$

where, R → radius of the cell and

D → distance between centers of the nearest co-channel cells.

**5. Define Grade of service.**

It is defined as the measure of the ability of a user to access a trunked system during the busiest hour.

**6. Differentiate narrowband and wideband systems.**

Narrowband systems – channel BW is smaller than coherence BW of channel-both TDMA and FDMA are used.

Wideband systems - channel BW is larger than coherence BW of channel-both TDMA and CDMA are used.

**7. Define Near-far problem.**

In CDMA strongest received mobile signal increases the noise floor. So the nearby subscriber's with strongest signal overpowers the base station receiver and drowns out the signals of far away subscribers.

8**. Differentiate fixed and dynamic channel assignment**.

Fixed channel Assignment - Channel groups are permanently assigned to cells. Even if the cannels are unused they remain idle.

Dynamic channel Assignment – Channel groups are under the control of MSC. When an user makes a call request the base station forwards the request to MSC and gets a cannel. Te cannel is given back after the termination of call.

9**. State advantages of CDMA over FDMA.**

CDMA are used for digital, FDMA are used for analog. CDMA is much more efficient due to compression and
the way that it send the signal. CDMA does not need to send a signal, taking up space, when you are not talking,but FDMA does.

**10. Define dwell time.**
The time over which the call may be maintained within a cell without handoff ismcalled as dwell time. This time is governed by factors such as propagation, interference, distance between subscribers and base station.

## PART-B

1. Compare FDMA, TDMA & CDMA?
2. Briefly explain the principle of cellular networks?
3. Write short notes on frequency reuse & channel assignment strategies?
4. Explain Handoff and interference systems?
5. Explain the Multiple Access methods with neat diagrams?
6. Explain Grade of service, blocked calls cleared, blocked calls delay?
7. Explain cell sectoring and cell splitting in detail?
8. Explain “repeaters for range extension” and “microcell zone” concept?
9. Calculate channel capacity of TDMA in cell system.
10. Calculate channel capacity of FDMA in cell system.
11. Calculate channel capacity of CDMA in cell system.
12. Write detail about interference and system capacity of cellular system
13. Write detail about trunking and grade of service of cell system
14. How to improve coverage and capacity of cellular system

## Unit – III Digital Signaling For Fading Channels

### Part – A

1. **Write the advantages of digital over analog modulation.**

Greater noise immunity, robustness to channel impairments, easier multiplexing of various forms of information, Greater security

**2. What is linear modulation and non linear modulation?**

In linear modulation technique, the amplitude of the transmitted (carrier) signal varies linearly with the modulating digital signal. In general, linear modulation does not have a constant envelope.

In non linear modulation, the amplitude of the carrier is constant regardless of the variation in the modulating
signal.

**2. Give the BER of GMSK.**

$P_e = Q(2\gamma E_b/N_o)$

**3. Define BW efficiency**

It is defined as the ratio of bit rate to the bandwidth

BW efficiency = R/B

R- bit rate in bps

B – BW in Hz

**4. Define training mode in an adaptive equalizer?**

First , a known fixed length training sequence is sent by the transmitter then the receivers equalizers may adapt to a proper setting of minimum bit error detection where the training sequence is a pseudo random binary signal or a fixed and prescribed bit pattern

**5. Mention some merits of MSK**

- Constant envelope
- Spectral efficiency
- Good BER performance
- Self-synchronizing capability
- MSK is a spectrally efficient modulation scheme and is particularly attractive for use in
- mobile radio communication systems.

**6. Why MSK cannot be directly used in multi user communications?**

1. The main lobe of MSK is wide. This makes MSK unsuitable for the applications where extremely narrow bandwidths and sharp cut-offs are required.

2. Slow decay of MSK power spectral density curve creates adjacent channel interference. Hence MSK cannotbe used for multiuser communications.

**7. State the advantages of offset-QPSK.**

The big advantage of OQPSK is to suppress out-of-band interference. The OQPSK will limit the phase-shift to not more than 90° at a time. This yields much lower amplitude fluctuations than non-offset QPSK .

**8. What is the need of Gaussian filter?**

Gaussian filters used before the modulator to reduce the transmitted bandwidth of the signal. It uses less bandwidth than conventional FSK.

**9. Define cyclic prefix.(Dec 2012)**

In OFDM, delay dispersion leads to a loss of orthogonality between the subcarriers and thus leads to Inter Carrier Interference (ICI). These negative effects can be eliminated by a special type of guard interval called the cyclic prefix. In cyclic prefix the last part of message is prepended to the start of message.

**10. What is PAPR? Give its reduction techniques.**

PAPR – Peak Average power ratio.

In OFDM PAPR is very high. It can be reduced by i) Coding

ii) Correction by additive function

iii) Correction by additive function

iv) Phase adjustment

**Part – B**

1. Discuss about QPSK transmitter and receiver with signal space diagram and give an expression for spatial effect
2. Explain $\frac{\pi}{4}$ QPSK transmitter and receiver with signal space diagram and give an Expression for spectral efficiency.
3. Explain windowing techniques in OFDM systems.
4. Explain cyclic prefixing in OFDM system
5. Explain orthogonal frequency division multiplexing with diagram
6. Discuss about the performance of digital modulation in frequency selective fading channels
7. Explain about the performance of digital modulation in flat fading channel
8. Explain GMSK transmitter and receiver with signal spacing diagram and give an expression for spectral efficiency
9. Briefly explain Peak Average Power Ratio(PAPR) in OFDM

10. What is MSK , explain with transmitter and receiver diagram . Explain the various types of demodulation of MSK.

## UNIT –IV Multi Path Mitigation Techniques

### Part-A

**1. Define adaptive equalizer and write its operating modes.**
To combat ISI, the equalizer coefficients should change according to the channel status so as to track the channel variations. Such an equalizer is called an adaptive equalizer since it adapts to the channel variations.
Operating modes: Training mode and tracking mode.

**2. What are the factors affecting the performance of adaptive algorithms**
Rate of convergence, Misadjustment, Computational complexity and numerical properties.
**3. What are the applications of non linear equalizers.**
Used in applications where the channel distortion is too severe, also noise power is not enhanced.
It is used in 2G and 3G cellular communication

**4. Define rate of convergence.**
The number of iterations required for the algorithm in response to stationary inputs to converge close enough to the optimum solution.

**5. What is the need for diversity schemes?**
To increase signal to noise ratio, For error free digital transmission, To degrade the bit error probability.

**6. Compare macro and micro diversity.**
**Macrodiversity** Large-scale fading is caused by shadowing due to variations in both the terrain profile. This cause Macrodiversity. The distance between the transmitters is much longer than the wavelength in Macrodiversity Forms of Macrodiversity: .COM
Spatial, Temporal, Frequency, Angular and Polarization microdiversities
Used to reduce large scale fading effects.

**Microdiversity**
Small scale fading results in a Rayleigh distribution of signal strength over small distances. This cause Microdiversity. In microdiversity the distance is in the order of or shorter than the wavelength.
Multiple reflections causes deep fading. This effect is reduced. Used to reduce small scale fading effects.

**7. Why nonlinear equalizers are preferred? List out the nonlinear equalization methods.**
The linear equalizers are very effective in equalizing channels where ISI is not severe. The severity of ISI isdirectly related to the spectral characteristics. In this case there are spectral nulls in the transfer function of the effective channel, the additive noise at the receiver input will be dramatically enhanced by the linear equalizer. To overcome this problem, non linear equalizers can be used.
Decision feedback equalization (DFE), Maximum likelihood symbol detection and Maximum likelihood sequence estimation (MLSE) are the nonlinear equalization methods used.

**8. Explain Diversity concept and list out its types.**

If one radio path undergoes a deep fade, another independent path may have a strong signal. By having more
than one path to select from, both the instantaneous and average SNRs at the receiver may be improved.
Types: Space diversity, Polarization diversity, Time diversity and Frequency diversity.

**9. Write the advantages of LMS algorithm.**
It maximizes the signal to distortion at its output within the constraints of the equalizer filter length, Low computational complexity and Simple program**.**

**10. List out the four types of Combining Methods.**
Selection combining, switched combining, Equal gain combining, Maximum ratio combining

**Part –B**

1. Derive for the mean square error for linear equalizer during training adaptive equalizer
2. Explain the working principle of nonlinear equalizer based on decision feedback equalizer
3. Derive the expression for least mean square algorithm
4. Write different kind of performance of adaptive equalizer algorithm are determine the various factor and explain.
5. Explain the detail of maximum like hood sequence estimation (MLSE) of Nonlinear equalizer
6. Write detail operation of micro diversity in terms of Special, Temporal, Frequency, Angle polarization
7. What you mean by combining diversity and explain selective, switching combining diversity
8. Explain the following
   a). Error probability in flat-fading channels
   b).Symbol error rate in frequency selective fading channel
9. Write brief explanation of Rake receiver
10. Write combining techniques using combination of signal
    a. Maximum ratio combining
    b. Equal gain combining
    c. optimum combining
    d. Hybrid selection -maximum ratio combining

**UNIT-V MULTIPLE ANTENNA TECHNIQUES**

## PART-A

**1. What is MIMO?**

Systems with more than one input and/ or more than one output are known as Multi-input Multi-output systems, or they are frequently known by the abbreviation MIMO. This is in contrast to systems that have only a single input and a single output (SISO).

**2. What are the models of MIMO systems?**

MIMO transfer functions are two-dimensional arrays of elementary SISO transfer functions. There are two ways to specify MIMO transfer function models: i) Concatenation of SISO transfer function models ii) Using transfer function with cell array arguments

**3. Define Channel state Information**

In wireless communications, **channel state information** (**CSI**) refers to known channel properties of a communication link. This information describes how a signal propagates from the transmitter to the receiver and represents the combined effect of, for example, scattering, fading, and power decay with distance. The CSI makes it possible to adapt transmissions to current channel conditions, which is crucial for achieving reliable communication with high data rates in multiantenna systems.

**4. Define Precoding**

Precoding is a technique which exploits transmit diversity by weighting information stream, i.e. the transmitter send the coded information to the receiver in order to the pre-knowledge of the channel. The receiver is a simple detector, such as a matched filter, and does not have to know the channel side information. This technique will reduce the corrupted effect of the communication channel.

**5. Define Beamforming**

It reflect the fact that the combiner performs an averaging over the noise at different antennas

**6. What is Multiple antenna system**

This systems have multiple antenne element at both communication link ends.

It includes Smart antenne and MIMO

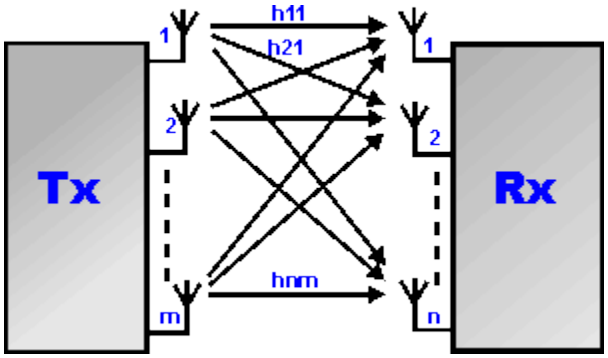
**7. Define Smart antenna**

A smart antenna is a digital wireless communications antenna system that takes advantage of diversity effect at the source (transmitter), the destination (receiver), or both. Diversity effect involves the transmission and/or reception of multiple radio frequency (RF) waves to increase data speed and reduce the error rate.

**8. Define *Spatial multiplexing***

***Spatial multiplexing :*** This form of MIMO is used to provide additional data capacity by utilising the different paths to carry additional traffic, i.e. increasing the data throughput capability.

**9. Draw the MIMO model**




**10. State the drawbacks of MIMO.**

1. Complex design
2. Challenge of placing multiple antenna
3. challenge of multi channel synchronization.

## PART-B

1. With diagram explain the system model for MIMO systems.
2. Discuss about the operation of spatial multiplexing systems.
3. Explain the operation of transmit precoding and receiver precoding schemes?
4. Why is beamforming important for wireless systems, With illustration explain transmit beamforming, receive beamforming and opportunistic beamforming.
5. Using diagrams explain transmit diversity and receive diversity.
6. Derive the capacity of a fading channel for information transmitted from a wireless system.
7. Derive the capacity of a Non fading channel for information transmitted from a wireless system.
8. What is channel state information? Explain the different kinds of channel state information.
9. What are smart antennas? Why are they required for and what are the different approaches for capacity gains?
10. Compare the capacity of a fading and a non fading channel for information transmitted from a wireless system.