EC2401 - WIRELESS COMMUNICATION

2MARKS:

UNIT 1

1.1.What is meant by frequency reuse?

If an area is served by a single Base Station, then the available spectrum can be divided into *N* frequency channels that can serve *N* users simultaneously. If more than *N* users are to be served, multiple BSs are required, and frequency channels have to be reused in different locations. Since spectrum is limited, the *same* spectrum has to be used for *different* wireless connections in different locations. This method of reusing the frequency is called as frequency reuse.

1.2. What are the trends in cellular radio systems?

The trends in personal cellular radio systems are:

i. PCS – Personal Communication Services
ii. PCN – Personal Communication Networks

1.3. What do you mean by forward and reverse channel?

Forward channel is a radio channel used for transmission of information from base station to mobile.Reverse channel is a radio channel used for transmission from mobile to base station.

1.4. What is the function of control channel? What are the types?

The function of control channel is to transmit call setup, call request, call initiation and Control. There are two types of control channels,

i. Forward control channel
ii. Reverse control channel

1.5. What is channel assignment? What are the types?

For efficient utilization of radio spectrum a frequency reuse scheme with increasing capacity and minimizing interference is required. For this channel assignment is used. The types of channel assignment are:

i. Fixed channel assignment
ii. Dynamic channel assignment.

1.6. What is fixed channel assignment?

If the channels in each cell are allocated to the users within the cell, it will be called as fixed channel assignment. If all channels are occupied, the call will be blocked.

1.7. What is dynamic channel assignment?

If the voice channels are not allocated permanently in a cell, it will be called as dynamic channel assignment. In this assignment, channels are dynamically allocated to users by the MSC.

1.8. Define MS, BS and MSC.

MS – Mobile station. A station in the cellular radio service intended for use.

BS – Base Station. A fixed station in a mobile radio system used for radio communication with MS.

MSC – Mobile Switching Centre. Mobile switching centre coordinates the routing of calls in large service area. It connects the base station and mobiles to PSTN. It is also called as MTSO(Mobile telephone switching office.

1.9. Define hand off and mode of hand off.

A handoff refers to the process of transferring an active call or data session from one cell in a cellular network to another or from one channel in a cell to another. A well-implemented handoff is important for delivering uninterrupted service to a caller or data session user. Modes of hand off are:

i. MCHO – Mobile Controlled Hand off
ii. NCHO – Network Controlled Hand off
iii. MAHO – Mobile Assisted Hand off

1.10. Write the types of hand off.

Types of handoff are:

i. Hard hand off – Mobile monitors BS and new cell is allocated to a call with strong signal.
ii. Soft hand off – MS with 2 or more calls at the same time and find which is the strongest signal BS, the MSC automatically transfers the call to that BS.

1.11**. Define Cell, Cluster.**

For a large geographic coverage area, a high powered transmitter therefore has to be used. But a high power radio transmitter causes harm to environment. Mobile communication thus calls for replacing the high power transmitters by low power transmitters by dividing the coverage area into small segments, called cells.

Each cell uses a certain number of the available channels and a group of adjacent cells together use all the available channels. Such a group is called a cluster.

1.12. What do you mean by foot print and dwell time?

The region over which the signal strength lies above this threshold value x dB is known as the coverage area of a BS and it must be a circular region, considering the BS to be isotropic radiator. Such **a circle, which gives this actual radio coverage, is called the foot print of a cell**.The time over which a call may be maintained within a cell without hand off is called the dwell time.

1.13. What are the major types of cellular interference?

The major types of cellular interferences are as follows

i. CCI – Co-channel interference is the interference between signals from co-channel cells.
ii. ACI – Adjacent channel interference resulting from signals which are adjacent in frequency to the desired signal.

1.14. What are the techniques used to expand the capacity of cellular system?

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.

1.15. What is frequency reuse ratio?

If the cell size and the power transmitted at the base stations are same then co-channel interference will become independent of the transmitted power and will depend on radius of the cell (R) and the distance between the interfering co-channel cells (D). If D/R ratio is increased, then the effective distance between the co-channel cells will increase and interference will decrease. The parameter Q is called the frequency reuse ratio and is related to the cluster size. For hexagonal geometry

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

$$= \frac{Distance\ between\ centres\ of\ the\ nearest\ co-channel\ cells}{Radius\ of\ the\ cell}$$

From the above equation, small of `Q' means small value of cluster size `N' and increase in cellular capacity.

1.16. Define FDMA, TDMA and CDMA.

FDMA - the total bandwidth is divided into non-overlapping frequency subbands.

TDMA – divides the radio spectrum into time slots and in each slot only one user is allowed to either transmit or receive.

CDMA – many users share the same frequency same tome with different coding.

1.17. Define Grade of service.

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

1.18. What is blocked call clear system (BCC)?

In a system, a user is blocked without access by a system when no channels are available in the system. The call blocked by the system is cleared and the user should try again .This is called BCC system.

1.19. What is blocked call delay system?

If a channel is not available immediately, the call request may be delayed until a channel becomes available. This is called as blocked call delay system.

1.20. Define cell splitting.

Cell splitting is the process of subdividing congested cells into smaller cells each with its own base stations and a corresponding reduction in antenna height and transmitter power. It increases the capacity of cellular system.

1.21. What is sectoring?

Sectoring is a technique for decreasing co-channel interference and thus increasing the system performance by using directional antennas.

1.22. What are the features of TDMA?

Features of TDMA are:

i. TDMA shares a single carrier frequency with several users, where each user makes use of non overlapping time slots.
ii. Data transmission occurs in bursts.
iii. Handoff process is much simpler
iv. Duplexers are not required, since transmission and reception occurs at different time slots.

1.23. What are the features of FDMA?

Features of FDMA are:

i. FDMA channel carries only one phone circuit at a time
ii. The bandwidth of FDMA channels are relatively narrow as each channel supports only one circuit per carrier.

UNIT 2

2.1. What are the propagation mechanisms of EM waves?

The four propagation mechanisms of EM waves are

i. Free space propagation
ii. Reflection
iii. Diffraction
iv. Scattering

2.2. What is the significance of propagation model?

The major significance of propagation model are:

i. Propagation model predicts the parameter of receiver.
ii. It predicts the average received signal strength at a given distance from the transmitter.

2.3. What do you mean by small scale fading?

Rapid fluctuations of the amplitude, phase as multipath delays of a radio signal over a short period of time is called small scale fading.

2.4. What are the factors influencing small scale fading?

The factors which influence small scale fading are:

Multipath propagation, Speed of the mobile, Speed of surrounding objects and the transmission bandwidth of the signal.

2.5. When does large scale propagation occur?

Large scale propagation occurs due to general terrain and the density and height of buildings and vegetation, large scale propagation occurs.

2.6. Differentiate the propagation effects with mobile radio.

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. Eg. Rayleigh fading, Rician fading and Doppler shift	It occurs when the user terminal (MS) moves for short distances.

2.7. Define 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).

$$F_D = f_r - f_0 = -f_0 V/C$$

Where f_0 -> transmission frequency

f_r -> received frequency

2.8. Differentiate time selective and frequency selective channel.

The gain and the signal strength of the received signal are time varying means then the channel is described as time selective channel. The frequency response of the time selective channel is constant so that frequency flat channel. The channel is time invariant but the impulse response of the channel show a frequency-dependent response so called frequency selective channel.

2.9. Define coherence time and coherence bandwidth.

Coherence time is the maximum duration for which the channel can be assumed to be approximately constant. It is the time separation of the two time domain samples. Coherence bandwidth is the frequency separation of the two frequency domain samples.

2.10. What do you mean by WSSUS channels?

In multipath channels, the gain and phase shift at one delay are uncorrelated with another delay is known as uncorrelated scattering of WSSUS.

2.11. What is free space propagation model?

The free space propagation model is used to predict received signal strength, when unobstructed line-of-sight path between transmitter & receiver. Friis free space equation is given by,

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

The factor $(\lambda/4\pi d)^2$ is also known as the free space loss factor.

2.12.Define EIRP.

EIRP (Equivalent Isotropically 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=PtGt
Where Pt-transmitted power in W
Gt-transmitting antenna gain

2.13. Explain 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.

$$PL(dB) = 10 \log P_t/P_r.$$

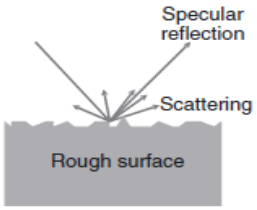
2.14. What is intrinsic impedance and Brewster angle?

Intrinsic impedance is defined by the ratio of electric to magnetic field for a uniform plane wave in the particular medium.
Brewster angle is the angle at which no reflection occurs in the origin. Brewster angle is denoted by θ_B as shown below,

$$sin(\theta_B) = \sqrt{\frac{\epsilon_1}{\epsilon_1 + \epsilon_2}}.$$

2.15. What is scattering?

When a radio wave impinges on a rough surface, the reflected energy is spread out in all directions due to scattering.



2.16. Define radar cross section.

Radar Cross Section of a scattering object is defined as the ratio of the power density of the signal scattered in the direction of the receiver to the power density of the radio wave incident upon the scattering object & has units of squares meters

2.17. Name some of the outdoor propagation models?

Some of the commonly used outdoor propagation models are

i. Longely-Rice model
ii. Durkin's model
iii. Okumura model.

2.18. Define indoor propagation models.

The indoor propagation models are used to characterizing radio propagation inside the buildings. The distances covered are much smaller, and the variability of the environment is much greater for smaller range of Transmitter and receiver separation distances. Features such as lay-out of the building, the construction

materials, and the building type strongly influence the propagation within the building.

2.19. Mention some indoor propagation models?

Some of the indoor propagation models are:

i. Long –distance path loss model
ii. Ericession multiple break point model
iii. Attenuation factor model.

2.20.What are merits and demerits of Okumara's model?

Merits:
Accuracy in parameter prediction.
Suitable for modern land mobile radio system.
Urban, suburban areas are analyzed.
Demerits:
Rural areas are not analyzed.
Analytical explanation is not enough.

2.21.List the advantages and disadvantages of Hata model?

Advantages: Suitable for large cell mobile system. Cell radius on the order of 1km is taken for analysis.
Disadvantages: Not suitable for PCS model. This model does not have any path specific correction.

2.22.What is the necessity of link budget?

The necessities of link budget are:

i. A link budget is the clearest and most intuitive way of computing the required Transmitter power. It tabulates all equations that connect the Transmitter power 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.

UNIT 3

3.1.List the advantages of digital modulation techniques.

The advantages of digital modulation techniques are:

i. Immunity to channel noise and external interference.
ii. Flexibility operation of the system.
iii. Security of information.
iv. Reliable since digital circuits are used.
v. Multiplexing of various sources of information into a common format is possible.
vi. Error detection and correction is easy.

3.2.What are the factors that influence the choice of digital modulation?

The factors that influence the choice of digital modulation are:

i. Low BER at low received SNR.
ii. Better performance in multipath and fading conditions.
iii. Minimum bandwidth requirement.

iv. Better power efficiency.
v. Ease of implementation and low cost.

3.3.Define power efficiency and bandwidth efficiency.

Power efficiency describes the ability of a modulation technique to preserve the fidelity of the digital message at low power levels.

$\eta_p = E_b/N_0$ = Bit energy / Noise power spectral density

Ability of a modulation scheme to accommodate data within a limited bandwidth is called bandwidth efficiency.

η_B = R/B = Datarate / Bandwidth in bps/Hz

3.4. What is QPSK?

The Quadrature Phase Shift Keying (QPSK) is a 4-ary PSK signal. The phase of the carrier in the QPSK takes 1 of 4 equally spaced shifts.

Two successive bits in the data sequence are grouped together.

1 symbol = 2 bits

This reduces bit rate and bandwidth of the channel.

Coherent QPSK = 2 x coherent BPSK system

The phase of the carrier takes on one of four equally spaced values such as $\pi/4$, $3\pi/4$, $5\pi/4$ and $7\pi/4$.

3.5. Define offset QPSK and $\pi/4$ differential QPSK.

In offset QPSK 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.

In $\pi/4$ QPSK, signaling points of the modulated signal are selected from two QPSK constellations which are shifted by $\pi/4$ with respect to each other. It is differentially encoded and detected so called $\pi/4$ differential QPSK.

3.6. What is meant by MSK?

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

3.7. List the salient features of MSK scheme.

Salient features of MSK are:

i. It has constant envelope, smoother waveforms than QPSK.
ii. Relatively narrow bandwidth.
iii. Coherent detection suitable for satellite communications.
iv. Side lobes are zero outside the frequency band, so it has resistance to co-channel interference.

3.8. Why GMSK is preferred for multiuser, cellular communication?

It is a simple binary modulation scheme.

Premodulation is done by Gaussian pulse shaping filter, so side lobe levels are much reduced. GMSK has excellent power efficiency and spectral efficiency than FSK.

For the above reasons GMSK is preferred for multiuser, cellular communication.

3.9.How can we improve the performance of digital modulation under fading channels?

By the using of diversity technique, error control coding and equalization techniques performance of the digital modulation under fading channels are improved.

3.10.Write the advantages of MSK over QPSK.

Advantages of MSK over QPSK:

i. In QPSK the phase changes by 90degree or 180 degree .This creates abrupt amplitude variations in the waveform, Therefore bandwidth requirement of QPSK is more filters of other methods overcome these problems , but they have other side effects.

ii. MSK overcomes those problems. In MSK the output waveform is continuous in phase hence there are no abrupt changes in amplitude.

3.11.Define M-ary transmission system?

In digital modulations instead of transmitting one bit at a time, two or more bits are transmitted simultaneously. This is called M-ary transmission.

3.12.What is quadrature modulation?

Sometimes two or more quadrature carriers are used for modulation. It is called quadrature modulation.

3.13.What is QAM?

At high bit rates a combination of ASK and PSK is employed in order to minimize the errors in the received data. This method is known as "Quadrature Amplitude Modulation".

3.14.**Define QPSK**

QPSK is defined as the multilevel modulation scheme in which four phase shifts are used for representing four different symbols.

3.15. What is linear modulation?

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

3.16. Define non linear modulation.

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

Non-linear modulations may have either linear or constant envelopes depending on whether or not the baseband waveform is pulse shaped.

3.17. What is the need of Gaussian filter?

Need for Gaussian Filter:

i. Gaussian filter is used before the modulator to reduce the transmitted bandwidth of the signal.

ii. It uses less bandwidth than conventional FSK.

3.18. Mention some merits of MSK.

Merits of MSK:

i. Constant envelope

ii. Spectral efficiency

iii. Good BER performance

iv. Self-synchronizing capability
v. MSK is a spectrally efficient modulation scheme and is particularly attractive for use in mobile radio communication systems.

3.19. Give some examples of linear modulation.

Examples of linear modulation:

i. Pulse shaped QPSK
ii. OQPSK

3.20. What are the techniques used to improve the received signal quality?

Techniques such as,

- Equalization
- Diversity
- Channel coding

are used to improve the received signal quality.

3.21. What is the need of equalization?

Equalization can be used to compensate the Inter Symbol Interference created by multipath within time dispersion channel.

3.22. What is diversity?

Diversity is used to compensate the fading channel impairments and is usually implemented by using two or more receiving antennas. Diversity improves transmission performance by making use of more than one independently faded version of the transmitted signal.

3.23. Define spatial diversity.

The most common diversity technique is spatial diversity, whereby multiple antennas are strategically spaced and connected to a common receiving system. While one antenna sees a signal null, one of the other antenna may sees a signal peak, and the receiver is able to select the antenna with the best signals at any time.

3.24. Define STCM.

Channel coding can also be combined with diversity a technique called Space-Time Coded Modulation. The space-time coding is a bandwidth and power efficient method for wireless communication.

3.25. Define adaptive equalization?

To combine Inter Symbol Interference, the equalizer coefficients should change according to the channel status so as to break channel variations. Such an equalizer is called an adaptive equalizer since it adapts to the channel variations.

3.26. 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.

3.27. What is tracking mode in an adaptive equalizer?

Immediately following this training sequence the user data is sent and the adaptive equalizer at the receiver utilizes a recursive algorithm to evaluate the channel and estimate filter coefficients to compensate for the distortion created by multipath in the channel.

3.28. Write a short note on linear equalizers and non linear equalizers?

Linear equalizers: If the output d(t) is not used in the feedback path to adapt the equalizer. This type of equalizers is called linear equalizer.

Nonlinear equalizers: If the output d(t) is fed back to change the subsequent outputs of the equalizers is called non linear equalizers.

3.29. Why non linear equalizers are preferred?

The linear equalizers are very effective in equalizing channels where ISI is not severe.The severity of the ISI is directly related to the spectral characteristics. In this case that there are spectral noise 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 are used.

3.30. What are the nonlinear equalization methods used?

Commonly used non linear equalization methods are:

i. Decision feedback equalization
ii. Maximum likelihood symbol detection
iii. Maximum likelihood sequence estimation

3.31. What are the factors used in adaptive algorithms?

Rate of convergence
Mis adjustments
Computational complexity

3.32. Define diversity concept.

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 often by as much as 20dB to 30dB. The principle of diversity is to ensure that the same information reaches the receiver on statistically independent channels.

UNIT 4

4.1. How the link performance can be improved?

Link performance can be improved by various techniques such as

i. Equalization
ii. Diversity
iii. Channel coding

4.2. Why diversity and equalization techniques are used?

To reduce ISI, Equalization technique is used. Diversity is used to reduce fading effects.

4.3.What is diversity?

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

4.4.Differentiate selection diversity and combining diversity.

Selection Diversity	Combining Diversity
The best signal is selected and processed while all other signals are discarded.	All signals are combined before processing and the combined signal is decoded.
Simple circuits are used.	At individual receiver, phasing circuits are needed.
None of the signal is not in acceptable SNR.	It works well.

4.5. Define Switched Diversity

If the signal level falls below the threshold, then the receiver switches to a new antenna which is called as switched diversity.

4.6. Define feedback or scanning diversity.

All the signals are scanned in a fixed sequence until one signal is found to be above a predetermined threshold.

4.7. Define temporal diversity.

Wireless propagation channel is time variant, so for sufficient decorrelation, the temporal distance between antennas must be atleast the half of maximum Doppler frequency.

4.8.What is meant by frequency diversity?

Correlation is increased by transmitting information on more than one carrier frequency. Frequencies are separated by more than one coherence bandwidth of the channel. So the signals will not experience same fades.

4.9.Differentiate micro and macro diversity.

Micro diversity	Macro diversity
Used to reduce small scale fading effects.	Used to reduce large scale fading effects.
Multiple reflection causes deep fading. This effect is reduced.	Deep shadow causes fading. This effect is reduced.
BS-MS are separated by small distance.	BS-MS are separated by large distance.

4.10.What is transmit diversity?

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

4.11.What is an equalizer?

Equalizer is a linear pulse shaping circuit which is used to reduce ISI.

4.12.What is linear and non-linear equalizer?

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. Simple and easy to implement. Not suitable for severely distorted channel. Noise power signal is enhanced.
Nonlinear equalizer: If the past decisions are correct, then the ISI contributed by present symbol can be cancelled exactly, feedback path is used. Suitable for severely distorted channel. Noise power signal is not enhanced. Complex in structure.
channels with low SNR. Suffers from error propagation.

UNIT 5

5.1. Write the two types of spread spectrum?

Types of spread spectrum are:
Direct Sequence Spread Spectrum (DS-SS)
Frequency hop spread spectrum (FH-SS)

5.2. What do you mean by spread spectrum?

Spread spectrum multiple access uses signals which have a transmission bandwidth whose magnitude is greater than the minimum required RF bandwidth. A pseudo noise (PN) sequence converts a narrowband signal to a wideband noise like signal before transmission

5.3. What is PN sequence?

Pseudo noise sequence is a coded sequence of 1's and 0's with autocorrelation properties.

5.4. When is the PN sequence called as maximal length sequence?

When the pseudo-noise sequence generated by linear feedback shift register has the length (N) of 2^m-1 where m is number of stages in shift register is called maximal length sequence.

5.5. Write the properties which a PN sequence should have.

Properties of PN sequence are:

i. Balance property
ii. Run property
iii. Correlation property

5.6. Define chip duration and chip rate.

The duration of every bit in PN sequence is known as chip duration. The number of bits (chips) per second is called chip rate.

5.7. What do you mean by processing gain of a spread spectrum?

$$\text{Processing gain} = \frac{\text{Bandwidth of spreaded data signal}}{\text{Bandwidth of unspreaded data signal}}$$

$$= \frac{\text{Bit Duration}}{\text{Chip duration}} = \frac{\text{Bandwidth}}{\text{Information rate}}$$

5.8.List the advantages and disadvantages of DS-SS.

Advantages of DS-SS:

i. The performance of DS-SS in presence of noise is superior to FH-SS.
ii. Good antijamming capability.
iii. Low multipath interference.

Disadvantages of DS-SS:

i. Poor synchronization.
ii. Requires large bandwidth.
iii. Long acquisition time so that the system is slow.

5.9. Define jamming and jamming margin.

Jamming is a multitone or powerful broad band noise. It is the ratio of the average interference power and the signal power.

Jamming margin in dB as the difference between the processing gain in dB and minimum SNR in dB.

5.10. What is meant by anti-jamming?

With the help of spread spectrum method, the transmitted signals are spread over the mid frequency band. Hence these signals appear as noise. Then it becomes difficult for the jammers to attack our signal. This method is called antijamming.

5.11.List the advantages and disadvantages of FH-SS.

Advantages of FH-SS:

i. High processing gain than DS-SS.
ii. Shorter acquisition time makes the system fast.

Disadvantages of FH-SS:

i. FH-SS requires large bandwidth.
ii. Circuit used for FH-SS is complex. Expensive frequency synthesizers are required.

5.12.List the types of FH-SS.

Types of FH-SS are:

i. Slow frequency hopping
ii. Fast frequency hopping

5.13.Compare slow and fast FH-SS.

Slow FH-SS	**Fast FH-SS**
More than one symbol is transmitted per hop.	One symbol is transmitted with more than one hops.
Chip rate is equal to the symbol rate.	Chip rate is equal to the hop rate.
Same carrier frequency is used to transmit one or more symbols.	One symbol is transmitted over multiple carriers in different hops.

5.14.Compare DS-SS and FH-SS.

DS-SS	FH-SS
PN sequence is multiplied with narrow band signal.	Data bits are transmitted in different frequency slots which are changed by PN sequence.
Modulation used is BPSK-coherent.	Modulation used is M-ary FSK noncoherent. Faster than DS-SS.
Fixed chip rate.	Variable chip rate.
Long acquisition time is required.	Short acquisition time.
Effect of distance is high.	Effect of distance is less.

5.15. State the principles of CDMA.

Principles of CDMA:

i. Many users share the same frequency.
ii. Each user is assigned a different spreading code.

5.16. How the capacity can be increased in CDMA?

Capacity in CDMA can be increased by

i. Quiet periods during speech transmission is shared by many users.
ii. Flexible data rate.
iii. Soft capacity.
iv. Error Correction coding used.

5.17.Write short notes on OFDM.

OFDM splits the information into N parallel streams which are modulated by N distinct carriers and then transmitted. In order to separate the subcarriers by the receiver, they have to be orthogonal.

5.18. Why cyclic prefix?

In delay dispersive channel, inter carrier interference occur. To overcome the effect of inter carrier interference and ISI, cyclic prefix is introduced. It is a cyclically extended guard interval whereby each symbol sequence is preceded by a periodic extension of the sequence itself.

5.19. Write the goals of GSM standard.

Better and more efficient technical solution for wireless communication. Single standard was to be realized all over Europe enabling roaming across borders.

5.20. What is W-CDMA?

It is a 3G wireless standard for cellular telephony. It provides better efficiency, higher peak rates upto 2 Mbps. Bandwidth of 5 MHz. Supports multimedia applications.

5.21.What are the services offered by GSM?

Services offered by GSM are:

i. Telephone services
ii. Bearer or Data services
iii. Supplementary services