ST.ANNE'S

COLLEGE OF ENGINEERING AND TECHNOLOGY

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(An ISO 9001:2015 Certified Institution)
Anguchettypalayam, Panruti – 607106.

QUESTION BANK

PERIOD: MAR2022 -MAY 2022 **BATCH**: 2019 – 2023

BRANCH: ECE **YEAR/SEM:**III/VI

SUB CODE/NAME: EC8652 WIRELESS COMMUNICATION

UNIT 1
WIRELESS CHANNELS
PART A

1. What is meant by multi path propagation? (Nov/Dec 2017)(D)

Multipath is the propagation phenomenon that results in radio signals reaching the receiving antenna by two or more paths. Causes of multipath include atmospheric ducting, ionospheric reflection and refraction, and reflection from water bodies and terrestrial objects such as mountains and buildings. Multipath causes multipath interference including constructive and destructive interference, and phase shifting of the signal.

2. Define fading.(D)

Fading is nothing but reduction in radio signal strength, normally caused by reflection or absorption of the signal

3. Compare fast and slow fading.(April/May 2018) (D)

Fast fading	Slow fading
1.high Doppler spread	1.low Doppler spread
2.coherence time is lesser than symbol period	2. Coherence time is greater than symbol period
3.channel variations faster than base band signal variation	3.channel variations slower than base band signal variation

4. Give the difference between frequency flat and frequency selective fading. (April/May 2018) (D)

Flat fading	Slow fading
1. Bandwidth of the signal is lesser than the bandwidth of the channel.	1. Bandwidth of the signal is greater than the bandwidth of channel.
2. Delay spread is lesser than symbol period	2. Delay spread is greater than symbol period

5. What is flat fading? (Nov/Dec 2017) (I.D)

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

6. Define Coherence time. In what way does this parameter decide the behavior of wireless channel? (April/May 2017) (D) (Nov/Dec 2018)(D)

It is defined as the required time interval to obtain an envelope correlation of 0.9 or less.

7. Define power delay profile(D)

The power delay profile provides indication of the dispersion or distribution of a transmitter power over various paths of the multipath structure

8 What is frequency selective fading? (Nov/Dec 2016) (D)

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

9. Calculate the Brewster angle for a wave impinging on ground having a permittivity of =5. (May/Jun 2016) (D)

0.409Brewster Angle = $\sin^{-1}(0.409) = 24.14$

10. Define coherence bandwidth. (May/Jun 2016) (D)

The coherence band width is related to the specific multipath structure of the channel. The coherence bandwidth is a measure of the maximum frequency difference for which signals are still strongly correlated in amplitude. This bandwidth is inversely proportional to the rms value of time delay spread.

11. Find the far field distance for an antenna with maximum dimension of 2m and operating frequency of 1 GHz. (Nov/Dec 2015) (D)

$Df = 2D^2/\lambda$**= 2 * 2 * 2/0.3 = 26.7 m**

12. State the difference between small-scale fading and large scale fading. (N/D 2015) (D)

- 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 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 large scale fading.

13. Mention a few techniques used to expand the capacity of a cellular system. (N/D 2015) (D)

- Cell splitting Cell
- sectoring Microcell
- zone conc

14. What is the major advantage of wireless communication? (April/May 2017) (D)

- Flexibility
- Lower Cost
- Ease of use

15. Define Co-channel Interference. (A/M 2016)(N/D 2016) (D)

Co-channel interference occurs between two access points (APs) that are on the same frequency **channel**. The reason that you should care is that **co-channel interference** can severely affect the performance of your wireless LAN (WLAN). The spectrum that's available for the deployment of WiFi is limited.

16. Define mean excess delay and rms delay spread. (A/M 2017)(R-8) (D)

The **mean excess delay**, rms **delay** spread and **excess delay** spread (X dB) are multipath channel parameters that can be determined from a power **delay** profile. The **mean excess delay** is the first moment of the power **delay** profile and is **defined** to be. Where P (τ) is the power measured at time τ.

17. Define Doppler shift. (D)

The shift in received signal frequency due to motion is called the Doppler shift.

18. What is Doppler spread? (D)

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

19. Write the conditions for flat fading. (D)

BW of signal<<BW of channel	Bs<<Bc
Symbol period>>Delay spread	T>>σλ

20. Write the conditions for frequency selective fading. (D)

BW of signal>BW of channel	Bs > Bc
Symbol period< Delay spread	Ts < σ[

21. What is ISI? (D)

Intersymbol interference (ISI) is a form of distortion of a signal in which one symbol interferes with subsequent symbols

22. Explain knife-edge diffraction model. (D)

Knife edge is the simplest of diffraction models, and the diffraction loss can be readily estimated using the classical Fresnel solution for the field behind the knife edge.

23. Write the effects of fading. (D)

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

24. What are the factors influencing small scale fading? (D)

Speed of surrounding objects, Multipath propagation, Speed of the mobile, Transmission bandwidth of the signal

26. What is meant by time dispersion? (D)

The received signal has a longer duration than that of the transmitted signal, due to the different delays of the signal paths. This is known as time dispersion.

27. Classify the wireless channels. (D)

Time-flat channels, Frequency -flat channels, Frequency-selective channels

28. What is the need of propagation model? (D)

Propagation models have traditionally focused on predicting the average received signal strength at a given distance from the transmitter, as well as the variability of the signal strength in close spatial proximity to a particular location. Propagation models that predict the mean signal strength for an arbitrary transmitter-receiver separation distance are useful in estimating the radio coverage area of a transmitter.

29. What is meant by frequency dispersion? (D)

The received signal has a larger bandwidth than that of the transmitted signal, due to the different Doppler shifts introduced by the components of the multipath. This is known as frequency dispersion.

30. What are the three most important effects due to multipath in mobile radio channel? (D)

Rapid changes in signal strength over a small travel distance or time interval, random frequency modulation due to varying Doppler shifts on different multipath signals.

31.What are the two factors that contribute to the rapid fluctuation of the signal amplitude?(Apr/May 2019)(ID)

- Multipath propagation
- Speed of the mobile

32. Differentiate small from large scale fading? (Apr/May 2019)(ID)

SMALL SCALE FADING	LARGE SCALE FADING
The rapid fluctuation in amplitude, phase of a radio signal over a short period of time or distance is called as small scale fading	The rapid fluctuation in amplitude, phase of a radio signal over a large area(hundreds of wavelength is called as large scale fading

33. Define fast fading(Nov/Dec 2018)

The channel impulse response changes rapidly within the symbol duration. This type of channel is called as fast fading channel.

PART B

Large scale path loss – Path loss models: Free Space -Link Budget design

1. (D) What do you meant by path loss model? Explain in detail about log-distance path loss model.(8) (Nov/Dec 2017) (D)

(ii) What is the need for link calculation? Explain with suitable example. (8) **(D)**

2. Distinguish fast fading and slow fading in wireless channel and explain in detail.(16**(Nov/Dec 2017) (D)**

3. Determine the proper spatial sampling interval required to make small-scale- propagation measurements which assume that consecutive samples are highly correlated in time. How many samples will be required over 10 m travel distance if fc = 1900 MHz and v = 50m/s. How long would it take to make these measurements, assuming they could be made in real time from a moving vehicle? What is the Doppler spread Bo for the channel? (5) **(May/Jun 2017) (D)**

Fading due to Multipath time delay spread

4. Describe in detail, the parameters of mobile multipath channels with their significance. (6) **(May/Jun 2017) (D)**

5. What is the need for link calculation? Explain with suitable example. **(N/D 2017) (I.D)**

6. What do you mean by path loss model? Explain in detail about log -distance path loss model. **(N/D 2017) (D)**

Fast fading – slow fading

7. Distinguish fast fading and slow fading in wireless channel and explain in detail. **(N/D 2017) (D)**

Free space model

8. In a free space propagation describe how the signals are affected by reflection, diffraction and scattering. (16) **(May/June 2016) (I.D) or** Describe the free space propagation model and the loss of signal strength**(Apr/May 2019)(ID)**

9. Describe briefly about free space propagation model (3)**(April/May 2018) (D)**

Doppler spread & Coherence time

10. Give a detailed note on Doppler spread and Coherence time. (16) **(D)**

Two-Ray models

12. If a transmitter produces 60W of power, which is applied to a unity gain, antenna with a 900 MHz carrier frequency, find the received power in dBm at a free space distance of 100m from the antenna. What is received power at a distance of 10 km? Assume unity gain for the receiver antenna. **(5) (May/Jun 2017) (D)**

13. Derive the path loss considering a Two -Ray Model for the propagation mechanism in a wireless channel. Is considering just two rays alone sufficient? Why? **(11) (I.D)**

Or

Explain the time variant two-path model of a wireless propagation channel. (16) **(Nov/Dec 2016)**

Or

With a neat sketch, compute received power and path loss during the 2 ray model. (16) **(I.D)**

14. (i) Find the advantages and disadvantages of the 2 ray ground reflection model in the analysis of path loss. (4) **(Nov/Dec 2015) (D)**

15. Explain fading effects due to multipath time delay spread and fading effects due to Doppler spread. **(10) (Nov/Dec 2016) (D) (Apr/May 2019)(ID)**

16. What are the factors influencing small scale fading? (6) **(Nov/Dec 2016) (D)**

17.If the transmit power is 1W and carrier frequency is 2.4GHZ and the receiver is at a distance of 1 mile(1.6km) from the transmitter. Assume that the transmitter and receiver antenna gain are 1.6

a) what is the received power in dbm in the free space of the signal?

b) what is the path loss in db

c)what is the transmission delay in ns? **(Apr/May 2019)(ID)**

18. Discuss the flat fading characteristics with relevant diagrams**(Apr/May 2019)(ID)**

19. Explain the various path loss models of large scale fading**(Nov/Dec 2018)(D)**

(ii) What is frequency selective fading? **(Nov/Dec 2018)(D)**

20. Describe small scale fading and derive expression for multipath channels**(Nov/Dec 2018)(D)**

UNIT II
CELLULAR ARCHITECTURE

PART A

1. Differentiate between FDMA, TDMA and CDMA technologies. (April/May 2018) (D)

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

2. What do you mean by forward and reverse channel? (Nov/Dec 2017) (D)

- 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

3. Define frequency reuse and how it is measured(Nov/Dec 2017) (April/May 2018) (D) (Nov/Dec 2018)(D)

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.

4. Why is cellular concept used for mobile telephony? (April/May 2017) (I.D)

Modern **mobile phone** networks **use** cells because radio frequencies are a limited, shared resource.**Cell**-sites and handsets change frequency under computer control and **use** low power transmitters so that the usually limited number of radio frequencies can be simultaneously **used** by many callers with less interference

6. Sate the advantages of CDMA over FDMA. (Nov/Dec 2016) (D)

CDMA technology has bandwidth thirteen times efficient than FDMA and forty times efficient than analog systems. CDMA also have better security and higher data and voice transmission quality because of the spread spectrum technology it uses, which has increased resistance to multipath distortion. CDMA has greater coverage area when compared to FDMA. The main advantage of the CDMA is that, in the single detection method it is more flexible than FDMA or joint detection. CDMA is said to have higher capacity than FDMA.

7. Define the grade of services. (Nov/Dec 2015, Nov/Dec 2016) (D)

Grade of Service in Wireless communication can be defined as ability of the user to connect on a call when the cell is being used by multiple users. It can be given by the ratio of number of blocked calls to the number of offered calls.

8. What is soft handoff in mobile communication? (May/Jun 2016) (D)

In Soft handoff, the mobile can simultaneously communicate with more than one AP during the handoff. This new connection is made before breaking the old connectio , and is r ferred to as make before break.

9. What is multiple access techniques? (May/Jun 2016) (D)

Multiple access technique enables two or more users to simultaneously share some finite piece of radio spectrum. Frequency division **multiple access** (FDMA) time division **multiple access** (TDMA) code division **multiple access** (CDMA)

10. Differentiate soft and hard handoff. (April/ May 2016). (D)

Hard handoff mode is characterized by a mobile having a radio link with only AP at any time. Thus, the old connection is terminated before a new connection is activated. This mode of operation is referred to as break before make.

In Soft handoff, the mobile can simultaneously communicate with more than one AP during the handoff. This new connection is made before breaking the old connection , and is referred to as make before break.

11. Define co-channel reuse ratio (Q). (Nov/Dec 2015) (D)

Co-channel reuse ratio Q is given as

Q = D/R, D – is the distance between centres of cells, R – radius of the hexagonal cell

12. Interpret Snell's law?(A/M 2015) (D)

Snell's law states that the ratio of the sines of the angles of incidence and refraction is equivalent to the ratio of phase velocities in the two media, or equivalent to the reciprocal of the ratio of the indices of refraction:

$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{v_1}{v_2} = \frac{n_2}{n_1}$$

14. What are the different types of multiple access schemes? (Dec 2013),(May 2016). (D)

FDMA- Frequency division multiple access-different frequencies are assigned to different users TDMA-Time division multiple access-different time slots are assigned to different users. CDMA-Code division multiple access-each user is assigned a different code.

15. What is the function of Medium Access Control Layer? (D)

The functions of Medium Access Control Layer which are responsible for establishes, maintains, and releases channels for higher layers by activating and deactivating physical channels.

16. What are the features of TDMA? (D)

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

17. How does near and far effect influence CDMA? What are counter measurements? (I.D)

The near and far effect is a server problem of wireless networks using CDM. All signals should arrive at the receiver with more or less the same strength. Precise power control is needed to receive all senders with the same strength at a receiver.

18. When handoff occurs? (D)

Hand-off occurs when a received signal from its serving cell becomes weak and another cell site can provide a stronger signal to the mobile subscriber. If the new cell-site has some free voice channels then its assigns one of them to the handed-off call.

19. What do you mean by foot print and dwell time? (D)

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

20. Define Set-up time. (D)

The time required to allocate a trunked radio channel to a requesting use

21. What are the different types of multiple access schemes? (D)

FDMA-Frequency division multiple access-different frequencies are assigned to different users TDMA-Time division multiple access-different time slots are assigned to different users. CDMA-Code division multiple access-each user is assigned a different code

22. Define dwell-time. (D)

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

23. What are the advantages of FDMA? (D)

The transmitter and receiver require much less digital signal processing

Synchronization is simple.

24. Define SAMA. (D)

Spread Aloha Multiple Access is a combination of CDMA and TDMA. The CDMA better suits for connection oriented services only and not for connection less burst data traffic because it requires to program both sender and receiver to access different users with different codes.

25. Define CDMA. (D)

Code Division Multiple Access systems use codes with certain characteristics to separate different users. To enable access to the shared medium without interference. The users use the same frequency and time to transmit data. The main problem is to find good codes and to separate this signal from noise.

The good code can be found the following 2 characteristic 1.Orthogonal. 2. Autocorrelation.

26. What is SDMA? (D)

Space Division Multiple Access (SDMA) is used for allocating separated spaces to users in wireless networks. The basis for the SDMA algorithm is formed by cells and sectorized antennas which constitute the infrastructure implementing space division multiplexing (SDM).

27. What limits the number of user in TDM and FDM compared to CDM? (D)

The code space is huge compared to the frequency space and time space. Because of the limited time space and frequency space, the number of user in TDM and FDM are limited.

28. Define FCA and DCA. (D)

Allocating a fixed frequencies for a channel is called as Fixed channel Allocation (FCA). In Dynamic Channel Allocation (DCA) scheme frequencies can only be borrowed, but it is also possible to freely allocate frequencies to cells. With dynamic assignment of frequencies to cells, the danger of the interference with cells with same frequency exists. Thus the borrowed frequencies in the surroundings cells can be blocked.

29. Define cell splitting. (D)

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.

30. What is the function of Medium Access Control Layer? (D)

The functions of Medium Access Control Layer which are responsible for establishes, maintains, and releases channels for higher layers by activating and deactivating physical channels

31. How does FDMA handle near-far problem?(Apr/May 2019)(ID)

FDMA assigns individual channels to individual users. Each user is allocated with a unique frequency subband for the duration of connection, whether the connection is in active or idle state. These channels are assigned on demand to users who request service. Hence this prevents near-far problem

32.What do you mean by mobile assisted handoff?(Apr/May 2019)(D)

In MAHO, the mobile measures the signal levels from the various APs using a periodic beacon generated by the APs(to keep track of the location of the mobiles). The mobile collects a set of power levels from different APs and feeds it back to the MSC, via the serving AP, for handoff decision making.

33. List the features of cellular concept(Nov/Dec 2018)(D)

1. It provides high quality service than the landline telephone systems.

2. It accommodates a large number of users over a large geographic area, within a limited

frequency spectrum

PART B

Multiple Access techniques - FDMA, TDMA, CDMA

1. Identify the channel capacity of TDMA in cell systems. **(Nov/Dec 2017) (D)**

2. Compare and Contrast the TDMA, FDMA and CDMA techniques. **(May 2016) (June 2013). (Nov/Dec 2018)(D)**

3. Describe the Operations of Cellular systems and Explain it steps with a neat sketch**(June 2013) (Nov/Dec 2018)(D)**

4**.** Write notes on (i) Trunking and (ii) Grade of service of a cellular system.iii) Cell splitting **(Nov/Dec 2017) (D) (Apr/May 2019)(ID)**

5. Describe the Channel Assignment Strategies.

6. (i) Describe Channel assignment strategies and Hand-off strategies. (10) **(April/May 2017)**

(ii) If a total of 33 MHz of bandwidth is allocated to a particular FDD cellular telephone system which uses two 25 kHz simplex channels to provide full duplex voice and control channels, compute the number of channels available per cell if a system uses (1) four-cell reuse (2)seven-cell reuse and (3)twelve-cell reuse. If 1 MHz of the allocated spectrums is dedicated to control channels, determine the equitable distribution of control channels and voice channels in each cell of each of the three systems. (6) **(D)**

7. (i) Derive the expressions for Cellular CDMA schemes for both noise limited and interference limited scenarios. (10) **(April/May 2017) (I.D)**

(ii) Consider Global System for Mobile, which is a TDMA/FDD system that uses 25 MHz for the forward link, which is broken into radio channels of 200 MHz. If 8 speech signals are supported on a single radio channel and if no guard band is assumed find the number of simultaneous users that can be accommodated in GSM. (2)

(iii) If GSM uses a frame structure where each frame consists of eight time slots, and each time slot contains 156.25 bits, and data is transmitted at 270.833 kbps in the channel, find (a) the time duration of a bit (b) the time duration of a slot (c) the time duration of a frame and (d) how long must a user occupying a Single time slot wait between two successive transmissions? (4)

8. Explain about co-channel interference and adjacent channel interference. Describe the techniques to avoid interference. (16) **(Nov/Dec 2016) (D)**

9**.** Summarize the features of various multiple access techniques used in wireless mobile communication. State the advantages and disadvantages of each technique. (16) **(May/Jun 2016) (D)**

Or

Discuss about the various multiple access techniques.

10**.** (i) Explain how frequency is efficiently allocated in a cellular radio system. (6) **(Nov/Dec 2016) (D)**

(ii) Explain in detail a handoff scenario at cell boundary. (10)

11**.** Explain in detail how to improve coverage and channel capacity in cellular systems. (16) **(May/Jun 2016) (I.D)**

12**.**(i) A cellular service provider decides to use a digital TDMA scheme which can tolerate a signal to interference ratio of 15 dB in the worst case. Find the optimal value of N for,

(a) Omni directional antennas (3)

(b) 120° sectoring (3)

(c) 60° sectoring (3)

(d) Should sectoring be used? If so, which case (60° or 120°) should be used? (Assume a path loss exponent of n=4 and consider trunking efficiency) (3) **(Nov/Dec 2015) (I.D)**

(ii) If a signal to interference ratio of 15 dB is required for satisfactory forward channel performance of a cellular system, what is the frequency reuse factor and cluster size that should be used for maximum capacity of the path loss exponent is (a) n=4 (b) n=3?

Assume that there are six co. Channel cells in the first tier, and all of them are at the same distance from the mobile. Use suitable approximation? (6)

13. Explain about co-channel interference and system capacity with neat diagrams. (16) **(Nov/Dec 2015) (D)**

Capacity Calculations

14. Discuss about the capacity calculations of cellular CDMA.(16)

Frequency reuse - channel assignment

15**.** Explain channel assignment and handoff strategies in detail.(13) **(Apr/may 2018) (D)**

16. (i) Discuss about frequency reuse. (9) **(D)**

(ii) Writes notes on channel assignment strategies or allocation techniques. (7) **(D)**

Interference & system capacity

17. (i) Write a short note on (8)

a. Blocked calls cleared b. Blocked calls delayed

18. What are the techniques to expand the capacity of cellular systems? Explain in detail. (16) **(D)**

Coverage and capacity improvement

19. Consider a time invariant frequency selective block fading channel consisting of 3subchannels of B=1MHz.the frequency response associated with each channel is H1=1,H2=2,H3=3.the transist power constraint is P=10mv and noise power spectral density is N0=10-9W/Hz. Find the Shannon capacity of the channel and optimal power allocation that achieves this capacity.(13) **(Apr/may 2018) (I.D)**

20. Consider a cellular system in which there are a total of 1001 radio channels available for handling traffic.

Suppose the area of a cell is 6 *k*��2 and the area of the entire system is 2100 *k*��2. (8)

a. Calculate the system capacity if the cluster size is 7.

b. How many times would the cluster of size 4 have to be replicated in order to approximately cover the entire cellular area?

c. Calculate the system capacity if the cluster size is 4.

d. Does decreasing the cluster size increase the system capacity? Explain.

21.Illustrate handoff scenario at cell boundaries

(Apr/May 2019)(ID)

22. How handoff in a cellular system is implemented?.Explain the types of handoff**(Nov/Dec 2018)(D)**

UNIT III
DIGITAL SIGNALING FOR FADING CHANNELS
PART A

1. What do you mean by cyclic prefix?(Apr/May 2018) (D)

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

2. Draw the constellation diagram for offset QPSK modulation scheme?(Apr/May 2018) (D)

3. Define offset QPSK and π/4 differential QPSK. (Nov/Dec 2017) (D)

In a π/4 differential QPSK, signaling points of the modulated signal are selected from two QPSK constellation which are shifted by π/4 with respect to each other.

In a OQPSK, after splitting the bit stream into odd and even, one bit stream is made offset by 1 bit period with respect to the other.

4. Define PAPR. (Nov/Dec 2017) (D) (Nov/Dec 2018)(D)

The peak to average power ratio PAPR is an important attribute of a communication system. A low PAPR allows the transmit power amplifier to operate efficiently, whereas a high PAPR forces the transmit power amplifier to have a large back off in order to ensure linear amplification of the signal.

5. What is the basic advantage of using multicarrier scheme such as OFDM? (April/May 2017) (D)

Makes efficient use of the spectrum by allowing overlap.

By dividing the channel into narrowband flat fading sub channels, OFDM is more resistant to frequency selective fading than single carrier systems are.

Eliminates ISI and IFI through use of a cyclic prefix.

Channel equalization becomes simpler than by using adaptive equalization techniques with single carrier systems.

It is possible to use maximum likelihood decoding with reasonable complexity.

6. State any 2 advantage of MSK. (April/May 2017) (D) (Nov/Dec 2018)(D)

- MSK, the output waveform is continuous in phase hence there are no abrupt changes in Amplitude.
- Constant envelope, Spectral efficiency, Good BER performance, Self-synchronizing capability p

7. Give the function of Gaussian filter in GMSK. (Nov/Dec 2016) (D)

The requirements for the **filter** are that it should have a sharp cut-off, narrow bandwidth and its impulse response should show no overshoot. The ideal **filter** is known as a **Gaussian filter** which has a **Gaussian** shaped response to an impulse and no ringing. In this way the basic MSK signal is converted to **GMSK** modulation.

8. What is cyclic prefix? (Nov/Dec 2016) (D)

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

9. Why is MSK referred to as fast FSK? (May/Jun 2016) (I.D)

MSK is called fast FSK, as the frequency spacing used is only half as much as that used in conventional non-coherent FSK.

10. What is windowing? (May/Jun 2016) (D)

Windowing is a technique proposed to help reduce sensitivity to frequency offsets in an OFDM system. This process involves cyclically extending **the time domain signal with each symbol by 'v'** samples. The resulting signal is then shaped with a window function

11. Find the 3dB bandwidth for a Gaussian LPF used to produce 0.25 GMSK with a channel data rate of Rb=270 kbps. What is the 90% power bandwidth in the RF channel? (Nov/Dec 2015) (D)

T=1/Rb=1/270*103=3.7 μs
B=0.25/T=0.25/(3.7*10-6) =67.567 KHz
90% power bandwidth
RF BW= 0.57Rb= 0.57*270*103= 153.KHz

12. Mention the difference between FDMA and OFDM. (Nov/Dec 2015) (D)

FDMA	OFDM
Spectrum overlapping is possible	Spectrum overlapping is not possible
Allows multiple data stream	Allows only one data stream which is broken into multiple signals

13. What are the modulations suitable for frequency selective mobile channels? (D)

Both filtered and unfiltered BPSK, QPSK, OQPSK and MSK modulations are suitable for frequency selective mobile channels.

14. Mention the merits and demerits of nonlinear modulation. (D)

Merits:

Lower efficient class c amplifiers can be used without introducing degradation in the spectrum occupancy of the transmitted signal.

Low out of band radiation of the order of -60dB to -70dB can be achieved.

Limiter-discriminator detection can be used, which simplifies receiver design and provides high immunity against random FM noise and signal fluctuations due to Rayleigh fading.

Demerits:

Constant envelope modulations occupy a larger bandwidth than linear modulation scheme

In situations where bandwidth efficiency is more important than power efficiency, constant Envelope modulation is not well suited.

15. What is QAM? (D)

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.

16. What is the advantage of MSK over QPSK? (D)

In QPSK the phase changes by 90 or 180 degrees. This creates abrupt amplitude variations in the waveform. Therefore bandwidth requirement of QPSK is more. MSK overcomes this problem. In MSK, the output waveform is continuous in phase hence there are no abrupt changes in amplitude.

17. Define M-ary transmission system(D)

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

18. What is meant by Frequency shift keying? (D)

If the frequency of the sinusoidal carrier frequency is varied depending on the incoming digital signal, then it is called Frequency shift keying.

19. What is meant by Phase shift keying? (D)

If phase of the carrier is varied depending on the input digital signal, then it is called phase shift keying.

20. What is meant by Amplitude shift keying? (D)

If amplitude of the carrier is varied depending on the incoming digital signal, then it is called

Amplitude shift keying.

21. What is Quadrature modulation? (D)

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

22. Mention any two criteria for choosing a modulation technique for a specific wireless application? (June 2013) (I.D)

The spectral efficiency of the modulation format should be as high as possible. This can best be achieved by a higher order modulation format. This allows the transmission of many data bits with each symbol. Adjacent channel interference must be small. This entails that the power spectrum of the signal should show a strong roll-off outside the desired band. Furthermore, the signal must be filtered before transmission.

23. What is the need of Gaussian filter? (Dec 13) (D)

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

24. What is nonlinear modulation? (D)

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

25. What is linear modulation? (D)

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.

26. Explain the following terms(D) a) Baud rate b) Bit rate

- Baud rate: Speed at which symbols are transmitted in a digital communication system, i.e. no of symbols/second.
- Bit rate: Speed at which data bits is transmitted in a digital communication system

27. Define M-ary transmission system. (D) (Apr/May 2019)(ID)

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

28. Write the advantages of digital over analog modulation. (D)

Greater noise immunity, Robustness to channel impairments, Easier multiplexing of various forms of information, Greater security

29. Define modulation. (D)

It is defined as the process by which some parameters of a high frequency signal termed as carrier, is varied in accordance with the signal to be transmitted.

30. What is demodulation? (D)

It is the process of recovering the original modulating signal from a modulated signal.

31. List the features of offset QPSK? (Apr/May 2019)(D)

- It supports more efficient RF amplification
- Phase transition occurs only once at every Tb seconds.
- It does not cause the signal envelope to go to zero.

PART B

Principles of Offset-QPSK, p/4-DQPSK

1. (i) Describe with neat diagram the modulation technique of QPSK. (8) **(Nov/Dec 2017) (D)**
(ii)List the advantages and applications of BPSK. (8) (Out of syllabus) **(D)**

2**.** (i) Discuss the error performance of different modulation schemes in fading channels. (10) **(April/May 2017) (D)**
(ii) What is Offset-QPSK? What is its advantage? Describe the Offset-QPSK scheme. (6) **(D)**

3. Explain in detail offset QPSK and π/4 DQPSK linear digital modulation techniques employed in wireless communication. (16) **(May/Jun 2016) (I.D)**

4. Derive the bit error rate for binary phase shift keying modulation for frequency flat fading channels.(13) **(Apr/May 2018) (D)**

5. Explain QPSK transmitter and receiver with signal space diagram and give an expression for spectral efficiency. **(Dec 2013)(Dec 2014)**

ii)State the principle and explain the working of offset QPSK**(Apr/May 2019)(ID)**

6. (i) Describe with a block diagram π/4 Quadrature phase shift keying and its advantages.
(ii)What is MSK? Explain its power spectral density. **(Dec 2014)**

Minimum Shift Keying

7. Examine the principle of MSK modulation and derive the expression for power spectral density. (16) **(Nov/Dec 2017) (D)**

8. Explain MSK transmitter and receiver with signal space diagram and give an expression for spectral efficiency. **(June 2013),(Dec 2015) (Nov/Dec 2018)(D)**

9. What is MSK? Also derive the expression of MSK signal as a special type of FSK signal and also explain its operations. (16) **(Nov/Dec 2016) (D)**

10**.** Derive the expression for MSK signal as a special type of continuous phase FSK signal.(16) **(Nov/Dec 2015) (D)**

11. What is MSK? Explain its power spectral density. (Dec 2014)

Gaussian Minimum Shift Keying

12. Why are constant envelope Modulation schemes such as MSK and GMSK used in a wireless? Communication system? Compare and contrast these two modulation techniques. (8) **(April/May 2017) (I.D)**

13. Explain in detail Gaussian Minimum Shift Keying (GMSK) transmission and reception with neat diagrams. (16**) (May/Jun 2016) (Nov/Dec 2015) (D)**

14. Explain GMSK transmitter and receiver with signal space diagram and give an expression for spectral efficiency.**(Dec 2015)(May 2016).**

15. Discuss about the performance of digital modulation in fading channels. **(Dec 2013)**

OFDM principle – Cyclic prefix

16. Draw the basic arrangement of orthogonal frequency division multiplexing transceivers and discuss its overall operation. (16) **(Nov/Dec 2016) (I.D)**

ii) Explain OFDM and compare it with FDMA**(Apr/May 2019)(ID)**

17. Explain in detail about OFDM modulation technique with necessary diagrams.

18. Describe OFDM scheme and state the reason behind using cyclic prefix in OFDM scheme. What is PAPR? Why is it' normally larger in an OFDM technique? (8) **(April/May 2017) (I.D)**

19. Prove that the OFDM system converts the delay spread channel into a set of parallel fading channels, using the concepts of cyclic prefix(13)**(Apr/May 2018) (I.D)**

Windowing

20. Write a detailed note on windowing techniques in OFDM system. (16) **(D)**
21. Explain the OFDM transmitter and receiver**(Nov/Dec 2018)(D)**
22. Why is O-QPSK is preferred in wireless communication system**(Nov/Dec 2018)(D)**

UNIT IV
MULTIPATH MITIGATION TECHNIQUES

PART A

1. **Distinguish between diversity gain versus array gain? (Apr/May 2018) (D)**

Array gain. In MIMO communication systems, **array gain** means a power **gain** of transmitted signals that is achieved by using multiple-antennas at transmitter and/or receiver, with respect to single-input single-output case.

The **diversity gain** is dependent on spatial correlation coefficients between antenna signals.

2. **Define spatial diversity. (Nov/Dec 2017) (D)**

The most common diversity technique is called 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 antennas may see a signal peak, and the receiver is able to select the antenna with the best signals at any time.

3. **Define STCM. (Nov/Dec 2017) (D)**

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.

4. **Why is an adaptive equalizer required? (April/May 2017) (D)**

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.

5. **What is diversity? Why it is employed? (April/May 2017) (D)**

A diversity scheme is a method that is used to develop information from several signals transmitted over independent fading paths. It exploits the random nature ofradio propagation by finding independent (uncorrelated) signal paths for communication.

6. **What is linear equalizers and non-linear equalizers? (Nov/Dec 2016) (D) (Nov/Dec 2018)(D)**

- If the output is not used in the feedback path to adapt, then this type of equalizer is called linear equalizer.
- If the output is fed back to change the subsequent outputs of the equalizer, this type of equalizer is called nonlinear equalizers.

7. **What is macro diversity? (Nov/Dec 2016) (D) (Apr/May 2019)(ID) (Nov/Dec 2018)(D)**

In the field of wireless communication, macro diversity is a kind of space diversity scheme using several receiver antennas and/or transmitter antennas for transferring the same signal. The distance between the transmitters is much longer than the wavelength, as opposed to micro diversity where the distance is in the order of or shorter than the wavelength.

8. **Define adaptive equalization. (May/Jun 2016) (D)**

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.

9. **What is the benefit of rake receiver? (May/Jun 2016) (D)**

Rake receiver gives the best performance among all the CDMA receivers.

Since correlators form the main working system of the receiver. The best version of the received signal is selected and given as output.

10. **What are the factors used in adaptive algorithms? (Nov/Dec 2015) (D)**

Rate of convergence

Misadjustment

Computational complexity and numerical properties.

11. **Name the three techniques used to improve signal quality(Apr/May 2019)(D)**

- Equalization
- Diversity
- Channel coding

12. **What is the need of equalization? (D)**

Equalization is used to compensate the inter-symbol interference created by multipath within time dispersion channel.

13. **What are the techniques used to improve the received signal quality?(D)**

Equalization, Diversity and Channel coding

14. **What is tracking mode in an adaptive equalizer? (D)**

Immediately following the 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.

15. **What is training mode in an adaptive equalizer? (D)**

First, a known fixed length training sequence is sent by the transmitter, then the receiver's equalizer may adapt to a proper setting of minimum bit error rate detection, where the training sequence is pseudorandom binary signal or a fixed and prescribed bit pattern.

16. **Write the functions of diversity(D)**

Diversity is used to compensate for fading channel impa rme ts, 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.

17. **What are the operating modes available in an adaptive equalizer? (D)**

Training and tracking modes.

18. **What are the advantages of lattice equalizer? (D)**

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

19. **Why non-linear equalizers are preferred? (D)**

The linear equalizers are very effective in equalizing channels where ISI is not severe. The severity of ISI is directly 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, nonlinear equalizers can be used.

20. **Where DFE are used? (D)**

DFE is particularly useful for channels with severe amplitude distortions and is widely used in wireless communications.

21. **Why feedback filter (FBF) in predictive DTE is called noise predictor? (I.D)**

FBF is **called** a **noise predictor**, because it forms an estimate (or a **prediction**) of

the noise and residual ISI contained in the signal a t the output of the FFF and subtracts from it the detector output after some feedback delay.

22. Differentiate between Macrodiversity and Microdiversty. (D)

Macrodiversity	**Macrodiversity**
In antenna diversity signal from antennas mounted at separate locations are combined.	In site diversity the receiving antennas are located at different receiver sites.
These antennas are located on the vehicle or the same base station tower and their spacing is a few wavelengths.	Signals from within a cell may be received at the different corners of the hexagonal area.

23. List out the four types of combining Methods. (D)

Selection combining, switched combining, Equal gain combining, Maximum ratio combining.

24. Define rate of convergence. (D)

The no of iterations required for the algorithm in response to stationary inputs to converge close enough to the optimum solution.

25. What are the nonlinear equalization methods used? (D)

Decision feedback equalization (DFE), Maximum likelihood symbol detection and Maximum likelihood sequence estimation (MLSE).

26. **Why diversity and equalization techniques are used? (D)**

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

27. **Define Switched Diversity(D)**

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

28. Define feedback or scanning diversity. (D)

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

29. Define temporal diversity. (D)

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

30. Mention the advantage of RAKE receiver. **(D)**

A RAKE receiver collects the different time delayed versions of original signal so that in multipath environment. if any useful information , available in multipath components is not left out. By receiving all possible multiple components with the help of separate correlation receivers for each multipath a better signal to noise ratio is achieved and finally it will lead to signal
quality.

Part B

1. Describe in detail about (i) Linear equalization (ii) Non-Linear equalization. (16) (**Nov/Dec 2017) (D)**

Or

Explain in detail about linear and non-linear equalizer. (16) **(May/Jun 2016) (D)**

2. Analyse various diversity techniques used in wireless communication. (7) **(Nov/Dec 2017) (D)**
(ii) Why is the equalization in a wireless system required to be adaptive?(6) **(Nov/Dec 2018)(D)**

3. (i) Describe the role played by Equalization and diversity as Multipath mitigation techniques. Compare and contrast these two techniques. (10) **(April/May 2017) (D)**
(ii) Consider the design of the US Digital Cellular equalizer, where f = 900 MHz and the mobile velocity v = 8.0 km/hr, determine the maximum Doppler shift, the coherence time of the channel and the

maximum number of symbols that could be transmitted without updating the equalizer assuming that the symbol rate is 24.3 k symbols/sec. (6)

4 (i) With a sketch, describe RAKE receiver. (6**) (April/May 2017) (D)**

(ii) Assume four 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. Compare this with the case of a single receiver without diversity. (4)

(iii) Derive an expression for performance improvement due to Maximal Ratio combining. (6)

5. Explain in detail the various factors to determine the algorithm for adaptive equalizer. Also derive the least mean square algorithm for adaptive equalizer. (16) **(Nov/Dec 2016) (D)**

6. Briefly explain about linear and non-linear equalizers.**(Dec 2013)(May 2016).**

Micro and Macro diversity

7. Write notes on: (16) **(May/Jun 2016) (D)**

(i) Space diversity

(ii) Frequency diversity

(iii) Polarization diversity

(iv) Time diversity

Or

Write a detailed note on micro diversity methods. (16)

8. Write a detailed note on macro diversity. (16)

9. Discuss in detail about the frequency diversity with multiple sketches. (16) **(Nov/Dec 2015) (D)**

10. With a neat block diagram explain the principle of Macro diversity

11. Discuss in detail about the different micro diversity concepts. **(May 2016).**

Adaptive equalization

12. Derive the mean square error for a Generic Adaptive Equalizer. (16) (**Nov/Dec 2015) (D)**

13. Explain the operation of an adaptive equalizer at the receiver side **(Dec 2014) (Apr/May 2019)(D)**

Zero forcing and LMS Algorithms

14. Give a detailed not on zero forcing algorithm for adaptive equalization. (8) **(D) (Nov/Dec 2018)(D)**

15. Write note adaptive equalizers. (8) **(D)**

Rake receiver

16. With relevant diagrams explain RAKE receiver. Also discuss how time diversity is achieved in a CDMA technique using RAKE receiver. (16) (**Nov/Dec 2016) (D)**

17. Explain the principles of RAKE receiver in detail.(13**) (April/May 2018) (D) (Nov/Dec 2018)(D)**

18. Explain equal gain Combining (EGC) diversity. (6) **(D)**

19. With relevant diagrams explain rake receiver in detail. (10) **(D)**

20. Discuss the performance of a RAKE receiver with a neat diagram.**(Dec 2013) (Apr/May 2019)(ID)**

UNIT V
MULTIPLE ANTENNA TECHNIQUES
PART A

1. List different types of diversity schemes. (April/May 2018) (D)

Microscopic diversity and macroscopic diversity.

2. State true or false: justify your answer: (April/May 2018) (I.D)

- Channel knowledge at the transmitter is not required in MIMO channels to extract multiplexing gain.
- Channel knowledge at the transmitter is not required in MIMO channels to extract diversity gain.

3. Define spatial multiplexing. (Nov/Dec 2017) (D) (Nov/Dec 2018)(D)

Spatial multiplexing is a MIMO wireless protocol that sends separate data signals or streams between antennae to enhance wireless signal performance or functionality. It is a type of "**spatial** diversity" and an engineering trick that helps to increase the possibili ies for various types of end-to-end transmission.

4. Define receiver diversity. (Nov/Dec 2017) (D) (Nov/Dec 2018)(D) Antenna diversity, also known as space diversity or spatial diversity, is any one of several wireless diversity schemes that uses two or more antennas to improve the quality and reliability of a wireless link. ... This is because multiple antennas offer a **receiver** several observations of the same signal.

5. What is spatial multiplexing? (April/May 2017) (D)

Spatial multiplexing (often abbreviated SM or SMX) is a transmission technique in MIMO wireless communication, Fibre-optic communication and other communications technologies to transmit independent and separately encoded data signals, known as "streams

6. What is channel state information? What is its benefit? (April/May 2017) (D)

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.

7. How does spatial multiplexing work? (Nov/Dec 2016) (D)

Spatial multiplexing uses MEA's (Multiple element antennas) at the transmitter for transmission of data streams. An original high-rate data stream is multiplexed into several parallel streams, each of which is sent from one transmit antenna element. The channel mixes up these data streams so that each of the receive antenna elements sees a combination of them.

8. What is ergodic capacity and outage capacity of a flat fading channel? (Nov/Dec 2017) (I.D) Ergodic Capacity: is the same as Shannon Capacity. Outage Capacity: is the

highest rate of communication that occurs given a certain outage probability. A measure for slow fading channels. Imagine that you want to transmit a block of symbols over a wireless channel (infinite block if we want to discuss capacity).

9. What is MIMO system? (May/Jun 2016) (D)

Systems with multiple antennas at the transmitter and receiver, which are commonly referred to as multiple- input multiple-output (MIMO) systems. The multiple antennas can be used to increase data rates through multiplexing or to improve performance through diversity.

10. What is meant by CSI? (Nov/Dec 2015) (D) (Nov/Dec 2018)(D)

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.

11. What is transmit diversity?(May/Jun 2016) (D)

In transmit diversity there are multiple transmit antennas, and the transmit power is divided among these antennas. Transmit diversity is desirable in systems where more space ,power ,and processing capability is available on the transmit side than on the receive side. Transmit diversity design depends on whether or not the complex channel gain is known to the transmitter.

12. What is antenna diversity)(Nov/Dec 2015) (D)

Antenna Diversity or Space Diversity or Spatial Diversity can be given as the diversity scheme followed in wireless communications to overcome multipath fading. More than one antenna are used for transmission and reception, and the main concept behind this method is the signals transmitted by different antennas undergo different fading and there is at least one robust version of the signal being received. This method requires more sophisticated hardware for synchronization.

13. List the application of MIMO (D)

- MIMO can reliably connect devices in home, such as computer networking devices, cabled video devices, phone lines, music, storage devices etc.
- The IEEE 802.16e standard and the IEEE 802.11n standard also use MIMO system.
- MIMO is used in mobile radio telephone standard such as 3GPP and 3GPP2 standard.
- 3GPP High Speed Packet Access Plus (HSPA+) and Long Term Evolution(LTE) standard use MIMO.

14. Write a note on precoding. (D) (Apr/May 2019)(D)

Precoding is a generalization of beam forming to support multi-stream (or multi-layer) transmission in multi-antenna wireless communications. In conventional single-stream beam forming, the same signal is emitted from each of the transmit antennas with appropriate weighting (phase and gain) such that the signal power is maximized at the receiver output. When the receiver has multiple antennas, single-stream beamforming cannot

simultaneously maximize the signal level at all of the receive antennas.[1] In order to maximize the throughput in multiple receive antenna systems, multi-stream transmission is generally required.

15. What is Alamouti's scheme? (D)

Alamouti's scheme is designed for a digital communication system with two-antenna. Transmit diversity. The scheme works over two symbol periods and it is assumed that the Channel gain is constant over this time. Over the first symbol period, two different symbolsS1 and S2 (each with energy Es/2) are transmitted simultaneously from antennas 1 and 2, respectively. Over the next symbol period, symbol −S*2 is transmitted from antenna 1 and symbol S*1 is transmitted from antenna 2, each again with symbol energy Es/2.

16. Write the disadvantages of MIMO systems. (D)

- MIMO systems entail significantly more circuit energy consumption than their single antenna counterparts, because separate circuitry is required for each antenna signal path.
- Signal processing associated with MIMO can be highly complex.

17. Write the advantages of MIMO system (D)

- Multiple-input multiple-output systems can significantly enhance performance of wireless systems through multiplexing or diversity gain.
- For a given transmit energy per bit, multiplexing gain provides a higher data rate whereas diversity gain provides a lower BER in fading.
- Support a higher data rate for a given energy per bit, so it transmits the bits more quickly and can then shut down to save energy.

18. What is beam forming? (D) (Apr/May 2019)(D)

The multiple antennas at the transmitter and receiver can be used to obtain array and diversity gain instead of capacity gain. In this setting the same symbol weighted by a compl x scale factor is sent over each transmit antenna, so that the input covariance matrix has u it rank. This scheme is also referred to as MIMO beamforming.

19. What is ergodic capacity and outage capacity of a flat fading capacity? (I.D)

Ergodic Capacity: is the same as Shannon Capacity. Outage Capacity: is the highest rate of communication that occurs given a certain outage probability. A measure for slow fading channels. Imagine that you want to transmit a block of symbols over a wireless channel (infinite block if we want to discuss capacity).

20. What is multiplexing gain? (D)

Multiplexing gain is defined as the increase in the data rate; since independent data streams are send through independent paths between multiple transmitters and multiple receivers. In other words if there are M (> 1) transmit antennas and N (> 1) receive antennas, the increase in the data rate is min (M, N)-fold

21. Describe threshold combining. (D)

Selection combining for systems that transmit continuously may require a dedicated receiver on each branch to continuously monitor branch SNR. A simpler type of combining, called threshold combining, avoids the need for a dedicated receiver on each branch by scanning each of the branches in sequential order and outputting the first signal whose SNR is above a given threshold γT . As in SC, co-phasing is not required because only one branch output is used at a time. Hence this technique can be used with either coherent or differential modulation.

22. State the importance of spatial multiplexing. (D)

The basic premise of spatial multiplexing is to send Mt independent symbols per symbol period using the dimensions of space and time. To obtain full diversity order, an encoded bit stream must be transmitted over all Mt transmit antennas. This can be done through serial encoding.

23. What is array gain? (D)

Array gain is defined as the average increase in the SNR and depends on the number of transmit and receive antennas. Transmit/Receive array gain needs channel information in the transmitter and receiver respectively. Channel information is typically available in the receiver whereas the channel state information in the transmitter is more difficult to maintain in general.

24. What are the advantages of Beamforming? (D)

Beamforming provides diversity and array gain via coherent combining of the multiple signal paths.

25.Compare DS-SS and FH-SS. (D)

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.

26. Write short notes on OFDM. (D)

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

27.Write the goals of GSM standard. (D)

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

28.State principles of CDMA.
(D)

Principles of CDMA:

i. Many users share the same frequency.

ii. Each user is assigned a different spreading code

29. How the capacity can be increased in CDMA

Capacity in CDMA can be increased by

1.A quiet period during speech transmission is shared by many users.
2.Flexible data rate.
3.Soft capacity.
4.Error Correction coding used.

PART B

MIMO Systems- System Model

1**.** What is meant by MIMO systems? Explain the system model with necessary diagrams. (16) **(Nov/Dec 2017) (D)**

2. Distinguish between different beam forming techniques. (16) **(Nov/Dec 2017) (D) (Nov/Dec 2018)(D)**

3. Discuss in detail, the capacity in fading and non-fading channels. (16) **(April/May 2017) (D)**

4. (D) With a neat diagram explain the system model for multiple input multiple output system. (8)

(Nov/Dec 2016) (D)

(ii) Discuss in detail the classifications of algorithms for MIMO based system. (8) **(D)**

5. Explain with relevant diagrams the layered space time structure with respect to MIMO systems. (16) **(May/Jun 2016) (I.D)**

6. Describe MIMO systems with emphasis on their requirement in a wireless communication environment. (8) **(April/May 2017) (I.D) (Nov/Dec 2018)(ID)**

7. Define Beamforming and briefly explain MIMO diversity gain.**(May 2016).**

8. Explain with relevant diagrams the layered space time structure with respect to MIMO systems.**(May 2016).**

9**.** Prove that 2*2 MIMO system (without channel state information) at the transmitter provides the diversity gain of 4 and array gain of 2 using Alamouti scheme.(13) **(April/May 2018) (I.D)**

10. Derive an expression for the capacity of the following systems. **(April/May 2018) (I.D)**

a) SIMO system assuming that the channel is known at receiver. (4)

b) MISO system assuming that the channel is known at transmitter. (4)
c) MIMO system assuming that the channel is known at transmitter(5)

Pre-coding - spatial multiplexing- Beam forming

11. Describe the concepts of Pre -coding and Beam forming. (8) **(D)**
12. Explain Pre-coding and Beam forming.
13. (D) Explain in detail how inherent delay in a multiuser system is overcome by beam forming. (8) (**May/Jun 2016) (I.D)**
(ii) Explain in detail about spatial multiplexing in MIMO system. (8) **(D)**

Capacity in fading and non-fading channels

14. Determine the capacity of frequency selective fading channel and explain the concept of water filling/water pouring. (16) **(Nov/Dec 2015) (D)**
15. Calculate the capacity of a MIMO system flat fading and non-fading channels. (16)
(Nov/Dec 2016) (D)

Channel state information

16. What is known as the channel state information? Explain in detail. (16) **(Nov/Dec 2015) (D)**
17. (D) What is known as channel state information? Explain in detail. (6) **(D)**
(ii) Explain receiver diversity in detail. (10) **(D)**
18**.** Determine the capacity of frequency selective fading and explain the concept of water filling/water pouring models. **(Dec 2015).**

19. Discuss the capacity of time-varying frequency-selective fading channels with respect to time- invariant channels and time-varying channels.

20. Explain the architectures of spatial multiplexing with neat diagram. **(May 2016)**
(Apr/May 2019)(ID)
21.Explain the concept of diversity with CSI at the transmitter and derive the expression for capacity**(Apr/May 2019)(ID)**
22. Derive and explain the capacity of naon fading channels**(Nov/Dec 2018)(D)**