DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
K.S.R. COLLEGE OF ENGINEERING: TIRUCHENGODE – 637 215.
COURSE / LESSON PLAN SCHEDULE

NAME   : Dr.J.GNANAMBIGAI   CLASS: VI- B.E.(ECE)

SUBJECT   : 16EC612 -WIRELESS AND CELLULAR COMMUNICATION

Text Books :

1.Rappaport. T.S., "Wireless communications", Pearson Education, 7th impression, 2012.
2. W.C.Y.Lee Mobile, "Communication Engineering",2nd Edition,McGraw Hill, 2012.
REFERENCES:
1. Jochen Schiller, "Mobile communications", PHI/Pearson Education, 2nd Edition (2003).
2. Gordon L. Stuber, "Principles of Mobile Communication",2nd Edition, Kluwer Academic publishers, 2004
3. Simon Haykin& Michael Moher,"Modern wireless Communication",PearsonEducation,2007.
4.Andreas.F.Molisch, Wireless Communication", John Wiley, 2006.

C. LEGEND:

L	-	Lecture	BB	-	Black Board
T	-	Tutorial	OHP	-	Over Head Projector
Tx	-	Text Book	pp	-	Pages
Rx	-	Reference	Ppt	-	Power point

Sl.No.	Lecture Hour	Topics to be covered	Teaching Aid Required	Book No. / Page No.
UNIT-IWIRELESS COMMUNICATION SYSTEMS				
1.	L1	Generation of wireless communication systems:2G,	ppt	Tx1/pp-25
2.	L2	Generation 3	ppt	Tx1/pp-25
3.	L3	Generation 4	BB	Tx1/pp-25
4.	L4	Examples of wireless systems: Cordless	BB	Tx1/pp-6
5.	L5	Paging system	ppt	Tx1/pp-12
6.	L6	Cellular telephone system	ppt	Tx1/pp-13
7.	L7	Comparison of wireless system	BB	Tx1/pp-18
8.	L8	Personal communication system	BB	Tx1/pp-20 Tx2/pp-17
9.	L9	**Call establishment on cellular systems**		
UNIT-II CELLULAR FUNDAMENTALS				
10.	L10	Frequency reuse	BB	Tx1/pp-58
11.	L11	Handoff	BB	
12.	L12	Channel assignment	BB	Tx1/pp-62
13.	L13,	Interference	BB	Tx1/pp-67

14.	L14	Improving coverage in cellular systems	BB	Tx1/pp-77
15.	L15	Improving capacity in cellular systems		
16.	L16	Radio propagation mechanisms	BB	Tx1/pp-113
17.	L17	Free space propagation		Tx1/pp-107
18.	L18	Two ray ground reflection model	BB	Tx1/pp-120

UNIT-III WIRELESS ACCESS SYSTEMS

19.	L19	Access methods: TDMA,	BB	Tx1/pp-455,Rx1/pp-73, Rx3/pp-233
20.	L20	FDMA,	BB	Tx1/pp-451,Rx1/pp-72, Rx3/pp-142
21.	L21	CDMA & CSMA	BB	Tx1/pp-460,468 Rx1/pp-76,Rx3/pp-245 Rx4/pp-372
22.	L22	Packet radio	BB	Tx1/pp-464 Rx4/pp-355
23.	L23	Pure ALOHA	BB	Tx1/pp-466,Tx2/pp-533 Rx3/pp-243,Rx4/pp-355
24.	L24	Slotted ALOHA	BB	Tx1/pp-467, Tx2/pp-535 Rx1/pp-76,Rx4/pp-245
25.	L25	Capacity of CDMA	BB	Tx1/pp-476
26.	L26	Capacity of SDMA	BB	Tx1/pp-486
27.	L27	OFDM	BB	Rx3/pp-162,Rx4/pp-399

UNIT- IV   ANTENNA DIVERSITY

28.	L28	SpaceDiversity	BB	Tx1/pp-329 Rx4/pp-242
29.	L29	TimeDiversity	BB	Tx2/pp-335
30.	L30	Polarization and Frequency Diversity	BB	Rx4/pp-247
31.	L31	Selection diversity improvement -	BB	Tx2/pp-339,Rx4/pp-245
32.	L32	Combining techniques	BB	Tx2/pp-351
33.	L33	Selective diversity combining	BB	Tx2/pp-351
34.	L34	Maximal ratio	BB	Tx2/pp-360
35.	L35	Equal gain combining,	BB	Tx2/pp-369
36.	L36	Feed forward and feedback combining	BB	Tx2/pp-381-384

UNIT –VSPREAD SPECTRUM TECHNIQUES

37.	L37	Basic principles: Direct sequence spread spectrum	BB	Rx1/pp-57
38.	L38	frequency hopping spread spectrum	BB	Rx3/pp-260
39.	L39	Spreading sequences	BB	Rx2/pp-464
40.	L40, L41	Power spectral density of DS spread spectrum signals	BB	Rx2/pp-475
41.	L42, L43	DS spread spectrum on frequency selective fading channels	BB	Rx2/pp-480
42.	L44	Error probability for DS	BB	Rx2/pp-501
43.	L45	Error probability for CDMA on AWGN channels	BB	Rx2/pp-491

2 MARKS Q&A

UNIT- I- Wireless Communication Systems

1. **Define Base Station.(R)(Co1)**

   A fixed station in mobile radio system used for radio communication with mobile stations. It is located at the center/edge of coverage region. It contains radio channels, transmitter, receiving antennas mounted on tower.

2. **What is control channel?(R) (Co1)**

   A Radio channel used for transmission of call setup, call request, call initiation and other control purposes.

3. **What is forward channel?(R) (Co1)**

   A Radio channel used for transmission of information from the base station to mobile.

4. **List out the frequency bands of radio spectrum**.(R) **(Co1)**

Designation	Abbreviation	Frequencies
Very Low Frequency	VLF	9 kHz - 30 kHz
Low Frequency	LF	30 kHz - 300 kHz
Medium Frequency	MF	300 kHz - 3 MHz
High Frequency	HF	3 MHz - 30 MHz
Very High Frequency	VHF	30 MHz - 300 MHz
Ultra High Frequency	UHF	300 MHz - 3 GHz
Super High Frequency	SHF	3 GHz - 30 GHz
Extremely High Frequency	EHF	30 GHz - 300 GHz

5. **List out some examples of frequency bands.(R) (Co1)**

   AM Radio – 533 Khz – 1.7 Mhz. FM Radio – 88 Mhz – 108 Mhz. TV Stations – 54 Mhz – 220 Mhz Cordless Phones- 40 -50 Mhz. Cellphones – 824- 849 Mhz. GPS - 1227 – 1575 Mhz.

6. **Why are electromagnetic waves with very low frequency not used for data transmission in computer networks? (R) (Co1)**

   Low frequency has longer wavelength, Data rates depends upon the bandwidth.

7. **What is a page? (R) (Co1)**

   It is a brief message which is broadcast over the entire service area, usually in a simulcast fashion by many base stations at the same time.

8. **Define Radio wave. (R) (Co1)**

   Radio wave is a electromagnetic wave propagated by the antenna. It has different frequencies and by tuning radio receiver to particular frequency a signal a be picked up.

9. **Classify the mobile radio transmission systems.(U) (Co1)**

   Simplex & Duplex

10. **State example for a half duplex system.(R) (Co1)**

    Push to talk and release to listen.

11. **List any four advantages of 3G Mobile Networks.**(April/May 2010)(R) **(Co1)**

faster data transmission speeds, easily access music, pictures and videos, improved messaging and Bluetooth capabilities are able to support 2G devices, users are able to access a variety of services within a network, ease of connecting to a network has been greatly enhanced, Bandwidth, security and reliability are more, Provides interoperability among service providers, Availability of fixed and variable rates, Support to devices with backward compatibility with existing networks, Rich multimedia services are available.

12. **What are the five functional entities of a DECT system?** (April/May 2010) **(R) (Co1)**

Portable handset, radio fixed part, Cordless controller, Network specific interface unit, Supplementary unit.

13. **What is Bluetooth?(Nov/Dec 2009) (R) (Co1)**

It is a standard for the short-range wireless interconnection of mobile phones, computers, and other electronic devices. It is used for exchanging data over short distances (using short-wavelength UHF radio waves in the ISM band from 2.4 to 2.485 GHz) from fixed and mobile devices, and building personal area networks (PANs).

14. **What are the advantages of CCS over conventional Signaling?** (Nov/Dec 2009) **(R) (Co1)**

Faster call setup, greater trunking efficiency, information transfer.

15. **Write some third generation wireless standards**.(U) **(Co1)**

Personal communication system, IMT-2000, UMTS

16. **What is near-far effect in wireless network? (R) (Co2)**

When used with FM or spread spectrum modulation, it is possible for the strongest user to successfully capture the intended receiver , even when many users are also transmitting . If the closest transmitter is able to capture a receiver because of small propagation path loss, it is called as near -far effect in wireless network.

17. **What are first, second, third generation cellular networks? (April/may 2011)(R) (Co1)**

I Generation: - FDMA/FD, Analog FM. II Generation:- Digital Modulation formats, TDMA/FDD, CDMA/FDD multiple access Techniques, GSM. III Generation:- Wideband CDMA(W-CDMA), Enhanced Data rate for Enhanced GSM Evolution (EDGE), Time Division Synchronous CDMA (TD-SCDMA).

18. **What is SIM? (April/May 2010) (U) (Co2)**

SIM-Subscriber identity module, which is memory device that store information such as the subscriber identity number, the network and countries where the subscriber is entitled to service, private key, and other user specified information.

19. **What is CDPD? (U) (Co2)**

CDPD is a Cellular packet digital Data System that uses packet switched data .The bit rate in the RF channel for CDPD is 19.2kbps

20. **What is SMS? (R) (Co2)**

SMS- short Messaging Service. It is a popular feature of GSM and allows subscribers to send short, real time messages to other subscribers in the same network by simply dialing a recipients cell phone number.

21. **What is 3G W-CDMA? (April/may 2011) (R) (Co2)**

It is an air interface standard designed for **'always on'** packet-based wireless service, so that computers, entertainment devices and telephony may all share the same wireless network and be connected to the internet, anytime, anywhere. It supports packet data rate upto 2.048Mbps/user – providing high quality of data, multimedia, streaming audio & video.

22. **What are Piconets? (April/May 2009) (R) (Co2)**
A Network of devices connected in adhoc fashion using bluetooth technology. A Piconets is formed when at least 2 devices are connected. It can support upto 8 devices. When piconet is formed, one device acts as a master and others acts as a slave.

23. **Differentiate GSM, EDGE (May/June 2012) (U) (Co2)**

GSM	EDGE
Global System for Mobile Communications, or GSM as it is popularly known, is the standard network adopted by most countries for mobile telephony.	EDGE, also known as Enhanced Data for Global Evolution or Enhanced GPRS, is a backward-compatible extension of GSM introduced in the market in 2003.
GSM network is classified as 2G network	EDGE is known as 2.75G although it completes the requirements of 3G network.
Slower Data transmission rate than EDGE.	it offers better and faster services to its users than GSM
To avail GSM services, you only need to have the appropriate network without worrying about the handset you choose.	To utilize the services of EDGE, both the phone and network should support EDGE, else the phone will automatically revert to GPRS.

24. **Compare AMPS & GSM. (Nov/Dec 2011,2013) (U) (Co2)**

GSM	AMPS
It is a analog mobile technology	It is a digital mobile technology
GSM, is the standard network adopted by most countries for mobile telephony.	AMPS is a standard system for analog signal cellular telephone service in the United States and is also used in other countries.
The frequency range specified for GSM is 1,850 to 1,990 MHz (mobile station to base station).	AMPS allocates frequency ranges within the 800 and 900 Megahertz.
Accessing method-TDMA	Accessing method-FDMA
Transmission Rate -270 kbps	Transmission Rate -10 kbps

25. **Give the applications of GPRS.(Nov/Dec 2013)(R) (Co2)**
Used for non-real time internet usage including retrieval of email, faxes and asymmetric web browsing

26. **Differentiate between 2G and 3G systems with respect to multiple access systems.(April/May 2008)(U) (Co2)**
2G make use of TDMA, FDMA that allow multiple subscribers to make calls simultaneously.
3G make use of WCDMA multiplexing to encourage the proper distribution of bandwidths to subscribers.

27. **What is meant by beacon? (R) (Co2)**
A beacon contains a timestamp and other management information used for power management and roaming. e.g., identification of the base station subsystem(BSS)

16 MARKS QUESTIONS

1. Explain a typical cellular system and explain various performance criteria. **(Nov/Dec 2011)(R) (Co1)**
2. Explain in detail the various cellular components.(April/May 2010)(R) **(Co1)**
3. Explain the process of operation of paging systems. (April/May 2010)(U) **(Co1)**
4. Summarize the steps involved in making a cellular telephone call. (April/May 2010)(U) **(Co1)**
5. Explain the operation of cellular systems. (Nov/Dec 2009)(U) **(Co2)**
6. Explain the procedure for making a call from a mobile to another mobile.(April/May 2009)(U) **(Co2)**
7. Explain how the interference between the base and mobile transmission is reduced in PCS. (April/May 2009)(U) **(Co2)**
8. Explain with suitable diagrams and specifications the difference between cellular, paging and cordless systems. (April/May 2009)(R) **(Co2)**
9. Compare and contrast the features of second generation digital cellular standards GSM and CDMA technologies.**(Dec 15)**
10. What are the advantages of cellular mobile communication systems over conventional mobile telephone system? (Dec 15)
11. Summarize the air interface specification parameters of major digital cordless telephone standards. (Dec 15)
12. Compare wireless communication systems with personal communication system**.** (Dec 15)

UNIT – II CELLULAR FUNDAMENTALS

28. **Define the term Roamer**. **(R)(Co3)**
   A mobile unit that operates in a service area other than that from which service has been subscribed.
29. **Recall the different types of cells. (R) (Co3)**
    Femto cells, pico cells, micro cells, macro cells and mega cells
30. **Define handoff. (R) (Co3)**
   When mobile moves from one cell to another the control of this mobile is transferred from one cell to another. This process is referred as handoff.
31. **Define cluster. (R) (Co3)**
   The N cells which collectively use the complete set of available frequencies is called a cluster.
32. **What are the basic units of a Cellular system? (R) (Co3)**
   Mobile stations, Base stations, Mobile Switching Center (MSC) or Mobile Telephone Switching Office (MTSO).
33. **Write the equation which illustrates the relation between capacity of a system and cluster size. (U) (Co3)**
   C = MKN
34. **What are the technical issues in planning of a cellular network? (R) (Co3)**
   Selection of frequency reuse pattern for different radio transmission techniques, Physical deployment and radio coverage modeling, Plans to account for the growth of the network, Analysis of the relationship between the capacity, cell size and the cost of infrastructure

35. **State the different classifications of channel assignment strategies. (U) (Co3)**
   Fixed and dynamic.
36. **What is the use of RSSI? (R) (Co3)**
   This is Receiver Signal Strength Indicator. This information is sent to the cell site from the mobile unit so that the MTSO can decide for a handoff.

37. **Recall the type of handoff used in CDMA. (R) (Co3)**
   Soft handoff.
38. **State the different types of handoffs.(U) (Co3)**
   Soft handoff, hard handoff, forced handoff, delayed handoff and mobile associated handoff.
39. **What is intersystem handoff? (R) (Co3)**
   During a course of a call, if a mobile moves from one cellular system to a different cellular system controlled by a different MSC it is referred as intersystem handoff.
40. **What is co channel interference?(Nov/Dec 2012) (R) (Co3)**
   Interference between signals from cells that operate in same frequency is referred as channel interference.
41. **What is grade of service?(Nov/Dec 2013) (R) (Co3)**
   It is a measure of the ability of a user to access a trunked system during the busiest hour.
42. **What is cell splitting? (R) (Co3)**
   It is a process of subdividing a congested cell into smaller cells.
43. **What is sectoring? (R) (Co3)**
   The process of using directional antennas in a cell is referred as sectoring.
44. **State the different techniques used for improving coverage and capacity in cellular systems. (U) (Co3)**
   Cell splitting, Sectoring, Repeaters for range extension and Microcell zone.
45. **Define modulation. (R) (Co3)**
   It is the process of encoding information from a message source in a manner suitable for transmission.
46. **What is frequency planning?(May/Jun 2013,Nov/Dec 2013) (R) (Co3)**
   The design process of selecting and allocating channel groups for the entire cellular base stations within a system is called frequency planning.
47. **State the basic constituents of a cellular system. (U) (Co3)**
   Mobile unit, cell site, mobile telephone switching office.
48. **State the expression that relates co channel reuse ratio (Q) to radius (R) of a cell (May 2010)(U) (Co3)**
   $Q = D/R$; D – Distance between center of co channel cells.
49. **State the expression used to locate co channel cells.(U) (Co3)**
   $N = i^2 + ij + j^2$
50. **Define the term dwell time. (R) (Co3)**
   The time over which a call may be maintained within a cell without handoff.
51. **State the advantage of umbrella cell approach. (U) (Co3)**
   It provides large area coverage to high speed users while providing small area coverage to users traveling at low speeds.
52. **Define co channel cells. (R) (Co3)**
   The cells that operate with the same set of frequencies are referred as co channel cells.
53. **How many co channels interfere is present in the first tier for a cluster size of 7?(U) (Co3)**

Six

54. What are the disadvantages of cellular systems with small cells? (R) (Co3)
Requires complex infrastructure, requires frequent hand-over, Involves complicated frequency planning

55. IF Bandwidth =33x10^{6}Hz, and forward and reverse channel bandwidth is 25x10^{3}Hz for a cell size of N=12, calculate the total channels and channel Bandwidth for full duplex. (April/may 2008)(A) (Co4)
Sol: Total bandwidth = 33Mhz. Channel Bandwidth = 25KHzx2 = 50Khz/Duplex channel
 Total Available channels = 33,000/50 = 660 Channels.
For N=12 total no. of channel available per cell = 660/12 = 55 channels.

56. If 20 MHz of total spectrum is allocated for a duplex wireless cellular systems and each duplex channel has 25Khz RF bandwidth, Find the number of duplex channels. (**April/May 2011). (A) (Co4)**
Total Spectrum = 20 MHz; Duplex channel bandwidth=25Khz;
Total Available channels = 20,000/25 = 800 Channels.

57. Define foot print. (R) (Co4)
The actual radio coverage of a cell is known as the foot print. It is determined from field measurements or propagation prediction models.

58. In wireless communication what is meant by cell dragging. (Apri/may 2008) (R) (Co4)
It is another handoff problem. It results from the pedestrian users that provide strong signal to base station and occurs in urban environment.

59. State the different techniques used for improving coverage and capacity in cellular systems.(April/May 2011, Nov/Dec 2013). (U) (Co4)
Cell splitting, cell sectoring, coverage micro zone approach.

60. How does cell split improve the efficiency of a mobile systems.(April/May 2008)(U) (Co4)
Cell splitting allows an orderly growth of cellular system. It increases the number of base stations in order to increase the capacity. It increases the number of times that channels are reused. Cell splitting allows a system to grow by replacing large cells with smaller cells thus increasing the efficiency.

61. What are the advantages of Microcell Zone Concept? (Nov/Dec 2009) (R) (Co4)
(i). same channel is maintained, when mobile travels from one zone to another zone within cell. (ii). The Effect of interference is highly reduced by using low power transmitters. (iii). Improved signal quality is possible. (iv) Reduced number of handoff when call is in progress.

62. Write 4 objectives of channel assignments. (Nov/Dec 2009)(U) (Co4)
(i). If a call request is made, it can be served only if there is any unused channels. (ii). If there is no unused channel call will be blocked. (iii). whenever call request is made, BS within cell will request the MSC to allocated channel.

63. What is soft handoff? Mention its advantages. (April/May 2009)(R) (Co4)
The ability to select between the instantaneous received signals from a variety of base station is called soft handoff.(Make before Break)
ADV: It exploits macroscopic space diversity at a different physical location. (ii) Selecting /turning is the key objective.

64. What is Hard Handoff? (April/May 2009) (R) (Co4)
The channelize wireless system that assign different radio channels during a handoff is called hard handoff. (Break before Make)

65. Explain adjacent channel interference. (April/May 2009,NOV/dec 2012)(U) (Co4)

The interference resulting from signals which are adjacent in frequency to the desired signal. It results from imperfect receiver filters allow nearby frequency to leak into the pass band. It is a serious problem if an adjacent channel user is transmitting in very close to subscriber's receiver when receiver attempts to receive a base station desired channel.

66. **Define Co-channel interference (April/May 2011)(R) (Co4)**

The cells that uses same set of frequencies in given area are called co-channel cells and the interference between signals from these cells is called co channel interference.

67. **Determine the co-channel reuse ratio for the cluster with 20 cells.(Nov/Dec 2013)(A)**

Q = D/R = SQRT(3N) = SQRT(3*20)=7.74

68. **What are the principles of Cellular Architecture? (U) (Co4)**

Low power Transmitters and Coverage Zones, Frequency Reuse, Cell splitting to increase Capacity, Hand off and Central Control.

69. **Specify the three partially separable effects of radio propagation.(R) (Co4)**

The three partially separable effects of radio propagation are, Multi path fading, Shadowing Path loss.

70. **Mention the basic propagation mechanisms, which impact propagation in mobile Communication.(may/June 2013) (R) (Co4)**

The basic propagation mechanisms are Reflection, Diffraction, and Scattering.

71. **What is reflection? (R) (Co4)**

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

72. **What is diffraction? (R) (Co4)**

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

73. **What is scattering? (April/May 2011) (R) (Co4)**

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

74. **Give the Parameters used for mobile multipath channels. (April/May 2011,Nov/Dec 2013) (R) (Co4)**

Time Dispersion Parameter, Coherence Bandwidth, and Doppler Spread and Coherence time.

75. **Define Multipath Propagation. (April/May 2011) (R) (Co4)**

In wireless telecommunications, **multipath** is the propagation phenomenon that results in radio signals reaching the receiving antenna by two or more paths.

76. **Define Brewster angle? (R) (Co4)**

The Brewster angle is the angle at which no reflection occurs in the medium of origin. It occurs when the incident angle b is such that the reflection coefficient Is equal to zero.

77. **Why we use 1m intercept for mobile communication? (R) (Co4)**

Within a 1m radius the antenna beam width of a high gain Omni-directional antenna is narrow in vertical plan. Larger the elevation angle weaker the reception level.

78. **State the effects of multipath Propagation (April/May 2008) (U) (Co4)**

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

79. **What is the advantage of 2 ray ground reflection model in the analysis of path loss? (April/May 2009) (R) (Co4)**

It is more accurate for predicting large scale signal strength over distance of several kilometers.

80. **What is Doppler shift? (April/May 2009, 2010) (R) (Co4)**

The Phase change in received signal due to the difference in path length hence the apparent change in frequency is called doppler shift.

$F_d = v/\lambda \cos\theta = 1/2\pi (\Delta\Phi/\Delta t)$.

81. **Calculate the brewster angle for a wave impinging on ground having a permitivity of $\varepsilon_r = 4$ (Nov/dec 2009)** (A) **(Co4)**

Sol: $\varepsilon_r = 4$ $\sin(\theta_B) = \sqrt{(\varepsilon_r - 1)}/\sqrt{((\varepsilon_r)^2 - 1)}$; $= \sqrt{4-1}/\sqrt{16-1} = \sqrt{1/5}$ $\theta_B = \sin^{-1}(\sqrt{1/5}) = 26.56°$

82. **Calculate Fraunhofer distance of an antenna at 60Mhz for a maximum dimension of 1m. (Nov/dec 2009) (April/May 2011)(Nov/Dec2012)(A) (Co4)**

Operating frequency f = 60Mhz; D =1 m; $\lambda = c/f = 3*10^8/60*10^6 = 5$

Distance $(d_f) = 2d^2/\lambda = 2(1)/5 = 0.4m$.

83. **Define Absolute bandwidth. (April/May 2010) (R) (Co4)**

The Term absolute bandwidth (B) denotes the width of the frequency interval occupied by a signal spectrum which ranges from lower cutoff frequency f_l to upper cutoff frequency f_u.

$B = f_u - f_l$

84. **What is free space propagation model? Write the expression for free space path loss (May/june 2012). (U) (Co4)**

It is used to predict the received signal strength when transmitter & receiver have clear, unobstructed LOS path between them.

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

16 MARKS QUESTIONS

1. Explain cellular Frequency Reuse. **(April /May 2009,Nov/Dec 2012) (R) (Co3)**
2. Explain the Channel Assignment strategies in mobile communication. **(April/ May 2008) (R) (Co3)**
3. What is Handoff? Explain the prioritizing, practical considerations.(**April/ May 2008,2013,Nov/Dec 2012)(U) (Co3)**
4. Explain the Interference (co channel & adjacent channel) **(April/May 2008) (R) (Co3)**
5. **Explain channel allocation strategies in detail.**
6. Explain the coverage and capacity improvements (splitting, sectoring, microzone) and derive necessary expressions **(NOV/DEC 2009,2011, May/June, Nov/Dec 2012,13)(R) (Co3)**
7. Prove that for a hexagonal geometry the cochannel reuse ratio is given by $Q=\sqrt{3N}$ where $N = i^2 + ij + j^2$. **(May /June 2012)(A) (Co4)**
8. A total of 24MHZ of Bw is allocated to a particular FDD cellular telephone system that uses two 30KHZ simplex channels to provide full duplex voice and control channels. Assume each cellphone user generates 0. 1 Erlangs of traffic .Assume Erlang B is used. (i) find the number of channels in each cell for a 4 cell reuse system (ii) if each cell is to offer capacity that is 90% of perfect scheduling. Find the maximum no of users that can be supported per cell where omnidirectional antennas are used at each BS **(May/June 2012).(A) (Co4)**
9. Derive a expression for Free Space Propagation Model. **(April/May 2011,2013)(A) (Co4)**

10. Derive the equation of the path loss for the 2 ray model with antenna gains.**(Nov/Dec 2009,2011)(May/June,Nov/Dec 2012, 2013)(A) (Co4)**

11. A mobile is located 5Km away from BS and uses a vertical λ/4 monopole antenna with a gain of 2.55dB to receive cellular radio signals. The E field at 1 Km from the transmitter is measured to be 10^{-3} V/m. The carrier frequency used for this system is 900MHZ. a) find the length and effective aperture of the receiving antenna. B) find the received power at the mobile using 2 ray ground reflection model assuming the height of the transmitting antenna is 50m and the receiving antenna is 1.5, above the ground. **(April/May 2011) pg.no.125(A) (Co4)**

12. if a transmitter produces 50W of power,express the transmit power in units of dbm and dbW. If 50 W is pplied to a unity gain antenna with a 900MHZ carrier frequency, find the received power in dbm at a free space distance of 100m from the antenna. What is Pr(10km)? assume unity gain for the receiver antenna.**(may/june 2013)pg.no.109(A) (Co4)**

UNIT- III – WIRELESS ACCESS SYSTEMS

85. **State certain access technologies used in mobile satellite communication systems**.(U) **(Co5)**
    FDMA, TDMA and CDMA.

86. **Specify some features of TDMA? (May/June 2012)(U) (Co5)**
    *In TDMA , no. of time slots depends upon modulation technique ,available bandwidth
    *Data transmission occurs in bursts
    *It uses different time slots for transmission and reception, then duplexers are not required
    *Adaptive equalization is necessary
    *Guard time should be minimized

87. **Specify some features of CDMA?(April/May 2011)(U) (Co5)**
    *In CDMA system, many users share the same frequency either TDD or FDD may be used
    *Channel data rate is high *Multipath fading may be substantially reduced
    *CDMA uses co –channel cells, it can use macroscopic spatial diversity to provide soft hand off.

88. **List out the non-linear effects in FDMA**.(R) **(Co5)**
    Nonlinearities cause signal spreading in the frequency domain and generate inter modulation (IM) frequencies. IM is undesired RF radiation which can interfere with other channels in FDMA systems.

89. **Write the equation to calculate the no. of channels in FDMA system**.(A) **(Co5)**
    $N = (B_t - 2B_{guard})/B_c$ B_t – Total spectrum Allocation. B_c – Channel Bandwidth ; B_{guard} - Guard band allocated at the edge of the allocated spectrum.

90. **Write the equation for number of channels in TDMA system.(A) (Co5)**
    $N = m(B_{tot} - 2B_{guard})/B_c$; B_t – Total spectrum Allocation. m- maximum no. of TDMA users on radio channel. B_c – Channel Bandwidth ; B_{guard} - Guard band allocated at the edge of the allocated spectrum.

91. **What is SDMA? (R) (Co5)**
    SDMA – Space Division Multiple Access. It controls the radiated energy for each user in space. It serves different users by using spot beam antennas. This different areas are covered by antenna beam may be served by same frequency or different frequencies.

92. **In an FDMA sytem, total spectrum bandwidth is 12.5Mhz, each channel is of 30Khz and guard band is 10kHz. Find the total number of channels available in the system.(May/june 2013)(A) (Co5)**

   $N = (B_{tot} - 2B_{guard})/B_c$; No. Of channels $N = 12.5*10^6 - 2 (10*10^3) / 30*10^3 = 416$ channels.

93. **What is hopping sequence? (May/June 2012) (R) (Co6)**

   The pattern of channel usage is called hopping sequence.

94. **What is multiple Access ? (Nov/Dec 2011) (R) (Co6)**

   Allowing many mobile users to share simultaneously a finite amount of radio spectrum.

95. **What is slotted Aloha?(**Nov/Dec 2012) **(R) (Co6)**

   In this, time is divided into equal time slots of lengths greater than packet duration π. Subscribers each have synchronized clocks and transmit a message only at the beginning of a new slot, thus resulting in a discrete distribution of packets.

96. **What is near-far problem? (R) (Co6)**

   In CDMA, power of multiple users at a receiver determines the noise floor after decorrelation. If the power of each user within a cell is not controlled, such that they do not appear equal at the base station receiver. It occurs when many mobile users share the same channel.

97. **How are guard spaces realized between users in CDMA? (R) (Co5)**

   The guard space between a pair of users in CDMA systems is the orthogonality between their spreading codes. The lower the correlation between any pair of spreading codes is, the better is the user separation.

   1.Suggest some measures which can be adopted in FDMA cellular system to overcome the problem of near far interference.

   2. How can the CDMA system be applied to overcome the near far interference problem.

16 MARKS QUESTIONS

1. Draw the frame structure of TDMA and derive its efficiency **(April /May 2009, 2010)(R)**
2. Derive the equation to calculate the number of users in CDMA cellular systems.(A) **(Co5)**
3. Comparison of TDMA, FDMA, SDMA, CDMA - explanation. **(April /May 2008,2011,2012,Nov 2012)(U) (Co5)**
4. Explain in detail about FDMA technique with neat sketch**.(April/May 2011)(R) (Co5)**
5. What are the types of multiple access techniques? Explain spread spectrum multiple access techniques and mention its merits and demerits**.(Nov/Dec 2013)(R) (Co5)**
6. Explain the concept of OFDM technique.
7. What are the limitations of pure ALOHA packet radio protocol? Explain how to overcome in slotted ALOHA Protocol?
8. Explain the carrier sensing multiple access protocol. Can CSMA/CD be used in cellular wireless networks**?** Why?

UNIT - IV

98. **Define Macroscopic Diversity. (Co7)**

When the mobile improves the average SNR on forward link by selecting non shadowed base station is called macroscopic diversity.

99. Give the practical space diversity considerations. (April/ May 2010) (Co7)

1. Selection diversity, Feedback diversity, Maximal ratio combining, Equal gain diversity

100. What is the need for using mobile station antennas? (April/May 2011) (Co7)

To enable connection to BS in all locations and orientations of mobile unit. It acts as a radiating element.

101. Mention the main functions of BS.(Nov/Dec 2011) (Co7)

Responsible for handling traffic and signaling between mobile phone and NSS, It carries transcoding of speech channels, allocation of radio channels to mobile phones, Transmission and reception over air interface.

102. Write the significance of diversity reception. (Nov/Dec 2011) (Co7)

Diversity scheme refers to a method for improving the reliability of a message signal by using two or more communication channels with different characteristics.

diversity reception: Radio reception in which a resultant signal is obtained by combining or selecting signals, from two or more independent sources, that have been modulated with identical information-bearing signals, but which may vary in their fading characteristics at any given instant. Diversity reception is used to minimize the effects of fading.

103. Give the types of Diversity. (May/June 2012) (Co7)

Space, Polarization, Frequency, Time diversities.

104. what is the theoretical maximum data rate that can be supported in a 200KHZ channel for SNR=10 dB,30dB? (May/June 2013)pg.no.280(Co7)

105. List any two mobile station antennas and state their significance(NOV/Dec 2013) (Co7)

Dipole Antenna and monopole Antenna**;** Normal mode helical antenna, Internal antennas, planar antenna, chip antenna; chip Antenna – very small mounted in certain manner on circuit board of phone. Normal mode helical antenna – used for circular polarization, dual band operation using 2 different pitch angles.

106. What is the need for combining? (Nov/Dec 2012) (Co7)

In order to provide coherent voltage addition and to provide optimal SNR.

107. Give two advantages of Digital modulation. (Nov/Dec 2012) (Co7)

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

108. What is a smart antenna? (Co8)

A smart antenna system consist of an antenna array, associated RF hardware and a computer controller that changes array pattern in response to radio frequency environment.

109. What is meant by diversity Reception? (April/May 2011) (Co8)

Radio reception in which a resultant signal is obtained by combining or selecting signals, from two or more independent sources, that have been modulated with identical information-bearing signals, but which may vary in their fading characteristics at any given instant. Diversity reception is used to minimize the effects of fading.

110. Define diversity. (R) (Co8)

Diversity is one very effective remedy that exploits the principle of providing the receiver with multiple faded replicas of the same information bearing signal.

111. List the types of diversity. (R) (Co8)

Diversity is of three types, Space,frequency and polarization diversity techniques.

112. Recall micro and macro diversity. (R)

Diversity techniques that mitigate the effect of multipath fading are called **micro diversity**, Diversity to mitigate the effects of shadowing from buildings and objects is called **macro diversity**. Macrodiversity is generally implemented by combining signals received by several base stations or access points.

113. Define Space diversity. (R) (Co8)

One method is to use multiple transmit or receive antennas, also called an antenna array, where the elements of the array are separated in distance. this type of diversity is referred to as *space diversity*.

114. What is polarization diversity? (R) (Co8)

A second method of achieving diversity is by using either two transmit antennas or two receive antennas with different polarization (e.g. vertically and horizontally polarized waves). The two transmitted waves follow the same path.

115. What is Frequency diversity? (R) (Co8)

Frequency diversity is achieved by transmitting the same narrowband signal at different carrier frequencies, where the carriers are separated by the coherence bandwidth of the channel. This technique requires additional transmit power to send the signal over multiple frequency bands.

116. List the methods how diversity can be achieved. (R) (Co8)

The methods by which diversity can be achieved generally fall into seven categories:i)space, ii) angle, iii) polarization, iv) field v) frequency, vi) multipath,and vii) time.

117. List the methods of diversity combining. (R) (Co8)

There are many methods for combining the signals that are received on the disparate diversity branches, and several ways of categorizing them. Diversity combining that takes place at RF is called predetection combining, while diversity combining that takes place at baseband is called postdetection combining.

118. What is selective combining? (R) (Co8)

With selective combining (SC), the branch yielding the highest signal-to noise ratio is always selected. In this case, the diversity combiner performs the operation For radio systems that use continuous transmission, SC is impractical because it requires continuous monitoring of all diversity branches.

119. Give the types of combining methods. (R) (Co8)

i.Diversity, ii, Selective combining,iii. Maximal ratio combining, iv. Equal gain combining and threshold combining.

120. Define maximal ratio combining. (R) (Co8)

In SC and SSC, the output of the combiner equals the signal on one of the branches. In maximal ratio combining (MRC) the output is a weighted sum of all branches, Since the signals are cophased, $\alpha i = aie-j\theta i$, where θ is the phase of the incoming signal on the ith branch.

121. Define equal gain combining. (R) (Co8)

Equal gain combining (EGC) is similar to MRC because the diversity branches are co-phased, but different from MRC because the diversity branches are not weighted. In practice, such a scheme is useful for modulation techniques having equal energy symbols, e.g., M-PSK.

16 MARKS QUESTIONS

1. Explain the frequency and time Diversity Techniques. **(April /May 2008) (April/May 2010) (NoV/Dec 2011) (R) (Co7)**
2. Explain in detail about antenna connections and locations on the mobile unit. What parameters control the design of mobile unit? Explain? **(Nov/Dec 2011) (R) (Co7)**

3. What is meant by diversity reception? Explain the various types of diversity **(Nov/Dec 2013)(U)**
4. Explain in brief about the diversity mechanisms with its types and ensure the improvement of SNR. **(R) (Co8)**
5. Explain the significance of combining technique with its advantages. **(R) (Co8)**
6. Evaluate how selection combining and maximal ratio combining provides a single improved signal in a diversity reception device. **(R) (Co8)**
7. Write short notes on Equal gain combining.**(U) (Co8)**
8. Explain in detail about the feed forward and feedback combining. (R) **(Co8)**
9. Explain the consideration of space diversity system.
10. Explain the theoretical model of polarization diversity.
11. Elaborate on selective diversity and equal gain combining techniques.

UNIT-V- Spread Spectrum

122. List the types of spreading codes. (R) (Co9)
   Short Code and Long code.

123. What is the function of DS Spread spectrum receiver? (R) (Co9)
   It performs three functions: synchronizing with incoming spreading sequence, despread the signal and detect the data.

124. What is the type of modulation technique used in the FHSS? (R) (Co9)
   Orthogonal M-ary FSK

125. Define spread spectrum. (R) (Co9)
   In telecommunication and radio communication, spread-spectrum techniques are methods by which a signal (e.g. an electrical, electromagnetic, or acoustic signal) generated with a particular bandwidth is deliberately spread in the frequency domain, resulting in a signal with a wider bandwidth. These techniques are used for a variety of reasons, including the establishment of secure communications, increasing resistance to natural interference, noise and jamming, to prevent detection, and to limit power flux density(e.g. in satellite downlinks).

126. List out the various applications of spread spectrum communication. (R) (Co9)
   Spread spectrum has the ability to resist the effect of intentional jamming, Spread spectrum is used in mobile communications. This is because the spread spectrum signal has the ability to resist the effects of multipath fading, Spread spectrum communication are used in distance measurement, Spread spectrum communications are secure. This secrecy capability of spread spectrum is used in military as well as in many commercial applications**.**

127. Define processing gain. **(R) (Co9)**
   In a spread spectrum system, the process gain (or 'processing gain') is the ratio of the spread (or RF) bandwidth to the unspread (or baseband) bandwidth. It is usually expressed in decibels (dB). For example, if a 1 kHz signal is spread to 100 kHz, the process gain expressed as a numerical ratio would be 100,000/1,000 = 100. Or in decibels, $10\log_{10}(100)$ = 20 dB.

128. List out the different types of frequency hopping. (R) (Co9)
   Slow Frequency Hopping, Fast Frequency Hopping

129. Compare DS-SS AND FH-SS (U) (Co9)

Parameter	Direct sequence spread spectrum	Frequency hop spread spectrum
Definition	PN sequence of large bandwidth is multiplied with narrow band data signal	Data bits are transmitted in different frequency slots which are changed by PN sequence
Effect of	This system is distance relative	Effect of distance is less in this system

distance		
Acquisition time	Acquisition time is long	Acquisition time is short

130. What is pseudo noise sequence? (R) (Co9)

Pseudo noise sequence is a noise like high frequency signal. The sequence is not completely random, but it is generated by well-defined logic. Hence it is called pseudo noise sequence. Pseudo noise sequences are used in spread spectrum communication for spreading message signals.

131. When is the PN sequence called as maximal length sequence? (R) (Co10)

When the PN sequence has the length of 2 m - 1, it is called maximal length sequence.

132. What are the Advantages of FH-SS System? (R) (Co10)

These systems bandwidth (spreads) are very large, they can be programmed to avoid some portions of the spectrum, they have relatively short acquisition time, the distance effect is less.

133. What are the Disadvantages of FH-SS System? (R) (Co10)

Those systems need complex frequency synthesizers, they are not useful for range and range-rate measurement, they need error correction.

134. Define synchronization in Spread Spectrum Systems(R) (Co10)

Spread spectrum systems are essentially synchronous. The pseudo noise sequences generated at the receiver and the transmitted must be same and locked at each other so that the transmitted signal can be extracted. The synchronization of the spread spectrum systems can be considered in two parts : Acquisition and tracking.

135. Define a random binary sequence. (R) (Co10)

A random binary sequence is a sequence in which the presence of a binary symbol 1 or 0 is equally probable.

136. What is Anti jamming? (R) (Co10)

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 send jamming signals. This is called anti jamming.

137. What is fast frequency hopping? (R) (Co10)

If the hop rate is an integer multiple of symbol rate (multiple hops per symbol) then it is called fast frequency hopping. In frequency hop spread spectrum, the frequency of the carrier hops randomly from one frequency to another frequency

138. What are the two function of fast frequency hopping? (R) (Co10)

Spread Jammer over the entire measure of the spectrum of Txed signal. Retuning the Jamming signal   over the frequency band of Txed signal

139. What is the advantage of a spread spectrum technique? (R) (Co10)

The main advantage of spread spectrum technique is its ability to reject interference whether it be the unintentional interference of another user simultaneously attempting to transmit through the channel (or) the intentional interference of a hostile transmitter to jam the transmission.

140. List the advantages of direct sequence systems (R) (Co10)

This system has best noise and antijam performance, unrecognized receivers find it most difficult to detect direct sequence signals, It has best discrimination against multipath signals.

141. List the disadvantages of direct sequence systems (R) (Co10)

It requires wideband channel with small phase distortion, It has long acquisition time, pseudo-noise generator should generate sequence at high rates, this system is distance relative.

142. Define slow frequency hopping (R) (Co10)

When several symbols are transmitted in one frequency hop (slot), then it is called slow frequency hopping. This means the symbol rate is higher than hop rate.

143. Define fast frequency hopping. (R) (Co10)

When several frequency hops take place to transmit one symbol, then it is called fast frequency hopping. This means the symbol rate is less than hop rate.

144. What are the properties of maximum length sequence? (R) (Co10)

Balance property: The number of 1's is always one more than the number of zeros in each period of a maximum length sequence

Run property: The run means subsequence of identical symbols i.e. 1's or 0's within one period of the sequence. The length of the run is equal to the length of the subsequence.

Correlation property: The auto correlation function of maximum length sequence is periodic and it is binary valued.

16 MARKS QUESTIONS

1. What are the main benefits of SS system? How can spreading be achieved? **(May/June 2011,2013)(R) (Co9)**
2. Explain in detail about frequency hopped multiple access**.(May/June 2013)(R) (Co9)**
3. Explain in detail the spread spectrum techniques with its types.(R) **(Co9)**
4. Derive the probability of error for DS CDMA on AWGN channels.(A) **(Co10)**
5. Derive the power spectral density of DS spread spectrum signals.(A) **(Co10)**
6. Explain the DSSS on frequency selective fading channels.(R) **(Co10)**
7. Explain the generation of direct sequence spread spectrum signal and its spectrum.
8. Evaluate the performance of FHSS signals in AWGN channel.