JEPPIAAR ENGINEERING COLLEGE

Jeppiaar Nagar, Rajiv Gandhi Salai – 600 119

DEPARTMENT OF

ELECTRONICS AND COMMUNICATION ENGINEERING

QUESTION BANK

VIII SEMESTER

EC6801 – WIRELESS COMMUNICATION

Regulation – 2013(Batch: 2015 -2019)

Academic Year 2017 – 18

Prepared by

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SUBJECT : EC6801– WIRELESS COMMINCATION

YEAR /SEM: IV /VIII

UNIT I WIRELESS CHANNELS

Large scale path loss – Path loss models: Free Space and Two-Ray models -Link Budget design – Small scale fading- Parameters of mobile multipath channels – Time dispersion parameters Coherence bandwidth – Doppler spread & Coherence time, Fading due to Multipath time delay spread – flat fading – frequency selective fading – Fading due to Doppler spread – fast fading – slow fading..

PART – A

CO Mapping : C409.1

Q.No	Questions	BT Level	Competence	PO
1	1. What are the propagation mechanisms of EM waves?	BTL-1	Remembering	PO1,PO3
2	What is the significance of propagation model?	BTL-1	Remembering	PO1,PO2,PO3
3	What do you mean by small scale fading?	BTL-1	Remembering	PO1,PO2
4	What are the factors influencing small scale fading?	BTL-1	Remembering	PO1,PO2
5	When does large scale propagation occur?	BTL-2	Understanding	PO1,PO3
6	Differentiate the propagation effects with mobile radio.	BTL-1	Remembering	PO1,PO4
7	Define Doppler shift. (Nov/Dec 2016)	BTL-1	Remembering	PO1,PO2
8	Differentiate time selective and frequency selective channel.	BTL-2	Understanding	PO1,PO2,PO3
9	Define coherence time NOV/DEC 2015	BTL-1	Remembering	PO1
10	What do you mean by WSSUS channels?	BTL-1	Remembering	PO1,PO3
11	What is free space propagation model?	BTL-1	Remembering	PO1
12	Define EIRP.	BTL-1	Remembering	PO1
13	Explain path loss.	BTL-1	Remembering	PO1,PO2,PO3
14	What is intrinsic impedance and Brewster angle? May/June 2016	BTL-1	Remembering	PO1,PO2
15	What is scattering?	BTL-2	Understanding	PO1,PO2
16	Define radar cross section.	BTL-1	Remembering	PO1,PO3
17	Name some of the outdoor propagation models?	BTL-1	Remembering	PO2,PO4
18	Define indoor propagation models.	BTL-1	Remembering	PO1,PO3
19	Mention some indoor propagation models?	BTL-1	Remembering	PO1,PO2
20	What are merits and demerits of Okumara's model?	BTL-1	Remembering	PO1,PO2
21	List the advantages and disadvantages of Hata model?	BTL-2	Understanding	PO1,PO2,PO3
22	What is the necessity of link budget?	BTL-1	Remembering	PO1,PO2
23	Find the far field distance for an antenna with maximum	BTL-1	Remembering	PO1,PO2,PO3

	dimension of 2 m and operating frequency of 1 GHz			
24	Define Coherence Bandwidth? NOV/DEC 2015, May/June 2016	BTL-1	Remembering	PO1,PO2
25	What is Slow fading?	BTL-1	Remembering	PO1,PO3
26	State the propagation effects in mobile radio	BTL-1	Remembering	PO1,PO2
27	What are the different fading effects due to Doppler spread?	BTL-1	Remembering	PO2,PO4
28	Write the effects of fading.	BTL-1	Remembering	PO1,PO3
29	What is fading and Doppler spread?	BTL-1	Remembering	PO1,PO2
30	What are the three most important effects due to multipath in mobile radio channel?	BTL-1	Remembering	PO1,PO2
31	Find the far field distance for an antenna with maximum dimension of 2 m and operating frequency of 1 GHz NOV/DEC 2015	BTL-1	Remembering	PO1,PO2,PO3
	PART – B&C			
1	Explain two-ray ground reflection model in detail (Nov/Dec 2016)	BTL-2	Understanding	PO1,PO2,PO3
2	Explain Fast fading and slow fading in detail	BTL-2	Understanding	PO1,PO2
3	Explain free space propagation model and explain the parameters of mobile multipath channel . May/June 2016	BTL-1	Remembering	PO1,PO2,PO3
4	Explain link budget design in detail	BTL-1	Remembering	PO1,PO3,PO4
5	Explain Flat fading and frequency selective fading in detail	BTL-1	Remembering	PO3,PO4
6	Explain the different parameters of mobile multipath channel. May/June 2016	BTL-2	Understanding	PO2,PO3
7	Explain the advantages and disadvantages of the two ray ground reflection model in the analysis of path lossii) In the following cases tell whether the two ray model could be applied and justify why or why not Case (i) : h_1=35m, h_r=3m, d=250 m case (ii) : h_1=30m, h_r=1.5m, d=450 m iii)Prove that in the two tray ground reflection model d =d''-d'=2$h_t h_r$/db)Derive the impulse response model of a multipath channel and also obtain the relationship between Bandwidth and received powerRefer Wireless communication, Rappaport Pg.No: 181 NOV/DEC 2015	BTL-2	Understanding	PO1,PO2,PO3
8	Explain the fading effects due to multipath time delays spread and fading effects due to doppler spread. (Nov/Dec 2016)	BTL-2	Understanding	PO2,PO3

UNIT II CELLULAR ARCHITECTURE				
Multiple Access techniques - FDMA, TDMA, CDMA – Capacity calculations–Cellular concept Frequency reuse - channel assignment- hand off- interference & system capacity- trunking & grade of service – Coverage and capacity improvement.				
PART – A				
CO Mapping : C409.2				
Q.No	Questions	BT Level	Competence	PO
1	What is meant by frequency reuse?	BTL-4	Analyzing	PO1,PO3,PO4
2	What is TDMA?	BTL-4	Analyzing	PO1,PO2,PO4
3	Define co channel reuse ratio. NOV/DEC 2015	BTL-1	Remembering	PO1,PO2
4	Types of channel Assignment	BTL-4	Analyzing	PO1,PO3,PO4
5	what is fixed channel assignment? May/June 2017	BTL-1	Remembering	PO1,PO2
6	Define MS, BS and MSC.	BTL-2	Understanding	PO1,PO2
7	Define hand off?	BTL-3	Applying	PO1,PO2
8	Define co channel interference. ? May/June 2017	BTL-1	Remembering	PO1,PO2
9	Define grade of service. (NOV/DEC 2015) (NOV/DEC 2016)	BTL-1	Remembering	PO1,PO2
10	What is adjacent channel interference	BTL-1	Remembering	PO1,PO3
11	What is dynamic channel assignment?	BTL-1	Remembering	PO1,PO3
13	Define hard hand off?	BTL-1	Remembering	PO1,PO2,PO3
14	Define soft hand off? May/June 2016	BTL-1	Remembering	PO1
15	Define cell and cluster	BTL-1	Remembering	PO1
16	What is CDMA?	BTL-2	Understanding	PO1
17	What is dwell time and what are the factor it depends on?	BTL-1	Remembering	PO2
18	Define foot print?	BTL-1	Remembering	PO1
19	Mention some indoor propagation models?	BTL-2	Understanding	PO1,PO2
20	What are merits and demerits of Okumara's model?	BTL-2	Understanding	PO1,PO2
21	List the advantages and disadvantages of Hata model?	BTL-1	Remembering	PO1,PO2
22	What is the necessity of link budget?	BTL-1	Remembering	PO1,PO2
23	Find the far field distance for an antenna with maximum dimension of 2 m and operating frequency of 1 GHz	BTL-1	Remembering	PO1,PO2,PO3
24	Define Coherence Bandwidth? NOV/DEC 2015, May/June 2016	BTL-2	Understanding	PO1,PO2
25	What is Slow fading?	BTL-2	Understanding	PO1
26	State the propagation effects in mobile radio	BTL-1	Remembering	PO1,PO2,PO3, PO4
27	What are the different fading effects due to Doppler spread?	BTL-1	Remembering	PO1,PO2,PO3, PO4
28	Write the effects of fading.	BTL-2	Understanding	PO2,PO3
29	What is fading and Doppler spread?	BTL-2	Understanding	PO2,PO3,PO4
30	What are the three most important effects due to multipath in mobile radio channel?	BTL-1	Remembering	PO1,PO2
31	Find the far field distance for an antenna with maximum dimension of 2 m and operating frequency of 1 GHz ? NOV/DEC 2015	BTL-2	Understanding	PO1,PO2,PO3

PART-B&C				
1	With the help of a neat diagram explain about frequency reuse and the advantages of it.	BTL-4	Analyzing	PO1,PO2,PO3, PO4
2	Give the difference between FDMA and TDMA.	BTL-1	Remembering	PO1,PO2,PO3
3	Explain the different techniques of improving coverage and capacity in Cellular System	BTL-1	Remembering	PO1,PO2,PO3
4	Explain in detail about reverse CDMA channel	BTL-1	Remembering	PO1,PO2,PO4
5	Compare and contrast the features of FDMA, TDMA and CDMA	BTL-2	Understanding	PO2,PO3,PO4
6	With neat diagram explain the forward CDMA channel Structure	BTL-2	Understanding	PO1,PO2,PO3
7	Summarise the features of various multiple access techniques used in wireless mobile communication. State the advantages and disadvantages of each techniques. May/June 2016	BTL-2 BTL-4	Understanding Analyzing	PO1,PO2,PO3
8	Explain about co-channel interference and adjacent channel interference. Describe the technique to avoid interference. (NOV/DEC 2016)	BTL-4	Analyzing	PO2,PO3,PO4
9	(i) Explain in detail how frequency is efficiently allocated in an cellular radio systems. (NOV/DEC 16) (ii) Explain in detail a handoff scenario at cell boundary. (NOV/DEC 2016)	BTL-2	Understanding	PO1,PO2

UNIT III DIGITAL SIGNALING FOR FADING CHANNELS				
Structure of a wireless communication link, Principles of Offset-QPSK, p/4-DQPSK, Minimum Shift Keying, Gaussian Minimum Shift Keying, Error performance in fading channels, OFDM principle – Cyclic prefix, Windowing, PAPR.				
PART – A				
CO Mapping : C409.3				
Q.No	Questions	BT Level	Competence	PO
1	State the difference between MSK and GMSK (Nov/Dec 2009).	BTL-2	Understanding	PO1
2	The types of modulation schemes used in mobile communication. (Nov/Dec 2009).	BTL-2	Understanding	PO1,PO2,PO3
3	Define Power efficiency. (May/June 2012)	BTL-1	Remembering	PO1,PO2
4	State the advantage of using GMSK rather than MSK. (Apr/May 2010)	BTL-1	Remembering	PO1,PO3
5	What is CPFSK? (Nov/Dec 2010)	BTL-1	Remembering	PO1
6	What is a diversity receiver? (Nov/Dec 2013)	BTL-1	Remembering	PO1
7	State the different types of line coding.(Nov/Dec 2014)	BTL-4	Analyzing	PO1,PO2
8	Rayleigh distribution is widely used in wireless communications? Why? Give any two reasons. NOV/DEC2008)	BTL-1	Remembering	PO1,PO2
9	What is coherent detector? (May/June 2013)	BTL-1	Remembering	PO1
10	Define absolute bandwidth? (April/May 2010).	BTL-1	Remembering	PO1
11	What is cyclic prefix? (Nov/Dec 2014) (Nov/Dec 2016)	BTL-1	Remembering	PO1
12	Write short notes on OFDM. (May/June 2012).	BTL-1	Remembering	PO1,PO2
13	Give some examples of linear modulation. ? May/June 2017	BTL-1	Remembering	PO1,PO2,PO3
14	Mention some merits of MSK. (Nov/Dec 2011)	BTL-1	Remembering	PO1
15	What is the need of Gaussian filter? (Nov/Dec 2016)	BTL-1	Remembering	PO1

16	Define non linear modulation. (Nov/Dec 2009)	BTL-1	Remembering	PO1
17	Define QPSK(Nov/Dec 2011)	BTL-2	Understanding	PO2
18	Define QAM(Nov/Dec 2007)	BTL-1	Remembering	PO1
19	Define M-ary transmission system?(April/May 2010).	BTL-1	Remembering	PO1,PO2
20	What are the techniques used to improve the received signal quality?	BTL-2	Understanding	PO1,PO2
21	Write the applications of MFSK and OFDM	BTL-1	Remembering	PO1,PO2
22	Mention any two criteria for choosing a modulation technique for a specific wireless application?	BTL-4	Analyzing	PO1,PO2,PO3, PO4
23	What are the main features of QPSK? (June 2014)	BTL-5	Evaluating	PO1,PO2,PO3
24	List the advantages of GMSK. (Dec 2014)	BTL-1	Remembering	PO1,PO2
25	State the advantages of offset-QPSK. (Dec 2014)	BTL-2	Understanding	PO1
26	What are the modulations suitable for frequency selective mobile channels?	BTL-1	Remembering	PO1,PO2
27	Why MSK cannot be directly used in multi user communications?(Dec 2012)	BTL-1	Remembering	PO2
28	Write the advantages of digital over analog modulation.	BTL-2	Understanding	PO2,PO3
29	Mention any two criteria for choosing a modulation technique for a specific wireless application? (June 2013)	BTL-1	Remembering	PO3,PO4
30	What is linear modulation and non linear modulation?	BTL-1	Remembering	PO2,PO3,PO4
31	Find the 3-dB bandwidth for a Gaussian low pass filter to produce 0.25 GMSK with a channel data rate of R_b=300 kbps NOV/DEC 2015	BTL-2	Understanding	PO2,PO4
32	An 900 MHz carrier signal is frequency modulated using a 100 kHz sinusoidal modulating waveform. The peak deviation of the FM signal is 500 kHz. If this FM signal is received by a super heterodyne receiver having an IF frequency of MHz, determine the IF bandwidth necessary to pass the signal NOV/DEC 2015	BTL-2	Understanding	PO4
33	. Why is MSK referred to as fast FSK? May/June 2016	BTL-1	Remembering	PO3
1	a) Explain the concept of minimum shift keying and Gaussion MSK. (8)b)How MSK signals are generated? Discuss in detail the demodulation techniquesfor MSK.(12) (Apr/May2015). (Nov/Dec 2016)	BTL-1	Remembering	PO2,PO3,PO4
2	Give a detailed description of OFDM transceiver. (Apr/May2015). (Nov/Dec 2016)	BTL-1	Remembering	PO3,PO4
3	(a)Describe with block diagram Offset-QPSK and its advantages.ANS: Refer section 6.85 in Wireless communication, Rappaport Pg.No:303 (b)Explain the concept of GMSK and mention its advantages (May/June 2012) May/June 2016	BTL-2 BTL-2	Understanding Understanding	PO2,PO3
4	Explain the principle of Pi/4 Differential QPSK from signal space diagram	BTL-2	Understanding	PO2,PO4

	(May/June 2013) May/June 2016			
5	Derive the expression for probability of error in flat – fading channels(May/June 2013)	BTL-1	Remembering	PO2,PO3,PO4
6	6.Briefly Explain the structure of wireless communication Link. (Nov/Dec2012.)	BTL-1	Remembering	PO2,PO3

UNIT IV PARALLELISM

UNIT IV MULTIPATH MITIGATION TECHNIQUES

Equalisation – Adaptive equalization, Linear and Non-Linear equalization, Zero forcing and LMS Algorithms. Diversity – Micro and Macrodiversity, Diversity combining techniques, Error probability in fading channels with diversity reception, Rake receiver, .

PART – A

CO Mapping : C409.4

Q.No	Questions	BT Level	Competence	PO
1	What are the techniques used to improve the received signal quality?	BTL-1	Remembering	PO1
2	What is the need of equalization? ? May/June 2017	BTL-1	Remembering	PO1,PO2,PO3
3	What is diversity? ? May/June 2017	BTL-1	Remembering	PO1,PO2
4	Define spatial diversity. ? May/June 2017	BTL-2	Understanding	PO1
5	Define STCM.	BTL-2	Understanding	PO1
6	. Define adaptive equalization? May/June 2016	BTL-1	Remembering	PO1
7	Define training mode in an adaptive equalizer?	BTL-1	Remembering	PO1,PO2
8	. What is tracking mode in an adaptive equalizer?	BTL-1	Remembering	PO1,PO2
9	Write a short note on linear equalizers and non linear equalizers? (Nov/Dec 2016)	BTL-1	Remembering	PO1
10	Why non linear equalizers are preferred?	BTL-1	Remembering	PO1
11	What are the nonlinear equalization methods used?	BTL-1	Remembering	PO1
12	What are the factors used in adaptive algorithms?	BTL-1	Remembering	PO1
13	Define diversity concept.	BTL-1	Remembering	PO1,PO2,PO3
14	How the link performance can be improved?	BTL-1	Remembering	PO1
15	Why diversity and equalization techniques are used?	BTL-1	Remembering	PO1
16	What is diversity?	BTL-1	Remembering	PO1
17	Differentiate selection diversity and combining diversity	BTL-2	Understanding	PO2
18	Define Switched Diversity	BTL-1	Remembering	PO1,PO2
19	Define feedback or scanning diversity	BTL-1	Remembering	PO1,PO2
20	Define temporal diversity.	BTL-1	Remembering	PO1,PO2
21	What is meant by frequency diversity?	BTL-1	Remembering	PO1,PO2
22	Differentiate micro and macro diversity.	BTL-1	Remembering	PO1,PO2
23	What is transmit diversity?	BTL-2	Understanding	PO1,PO2,PO3
24	What is an equalizer?	BTL-1	Remembering	PO1,PO2
25	What is linear and non-linear equalizer	BTL-2	Understanding	PO1
26	What is linear and non-linear equalizer? (Nov/Dec 2007)	BTL-1	Remembering	PO1,PO2
27	What is transmit diversity? (May/June 2013)	BTL-1	Remembering	PO1
28	Differentiate micro and macro diversity. (Nov/Dec 2011) (Nov/Dec 2016)	BTL-2	Understanding	PO2,PO4

29	Why diversity and equalization techniques are used? (May/June2008)	BTL-1	Remembering	PO3,PO4
30	What are the nonlinear equalization methods used? (Nov/Dec 2010)	BTL-1	Remembering	PO2,PO3
31	What are the benefits of RAKE receiver? May/June 2016	BTL-1	Remembering	PO2
32	If a digital processing chip can perform one million multiplications per second. Determine the time required between each iteration for the following adaptive equalizer algorithm NOV/DEC 2015	BTL-2	Understanding	PO3
PART B&C				
1	Write short notes on : May/June 2016 (i) Spatial diversity (ii) Frequency diversity (iii) Polarization diversity (iv) Time diversity	BTL-1	Remembering	PO3,PO4
2	With a diagram explain the performance of RAKE receiver? (Nov/Dec 2016)	BTL-1	Remembering	PO2,PO3
3	Enumerate the fundamental of equalization and reduction in intersymbol interference in communication channels.	BTL-1	Remembering	PO2,PO3
4	What is the non linear equalization? Explain the three non linear methods of Equalization with Suitable diagrams? May/June 2016	BTL-1	Remembering	PO3,PO4
5	Enumerate the algorithm of adaptive equalization and explain. (Nov/Dec 2016)	BTL-1	Remembering	PO2,PO3
6	Briefly explain Diversity combining techniques.	BTL-2	Understanding	PO2,PO3,PO4
7	Consider a single branch Raleigh fading signal has a 20% chance of being 6dB below some mean SNR threshold	BTL-2	Understanding	PO2,PO4
8	Derive the mean square error for a Generic Adaptive Equalizer	BTL-2	Understanding	PO2,PO3
UNIT V MULTIPLE ANTENNA TECHNIQUES				
MIMO systems – spatial multiplexing -System model -Pre-coding - Beam forming - transmitter diversity, receiver diversity- Channel state information-capacity in fading and non-fading channels.				
PART – A				
CO Mapping : C409.5				
Q.No	Questions	BT Level	Competence	PO
1	Why need MIMO system?	BTL-4	Analyzing	PO1,PO3,PO4
2	What are the Types of MIMO System? May/June 2017	BTL-2	Understanding	PO1,PO2,PO3
3	What is Single User MIMO (SU-MIMO): ? May/June 2017	BTL-1	Remembering	PO1,PO2
4	What is Multi User MIMO (MU-MIMO):	BTL-1	Remembering	PO1
5	What is Space Time Transmit Diversity (STTD) MIMO	BTL-1	Remembering	PO1
6	What is Spatial Multiplexing (SM) MIMO (Nov/Dec 2016)	BTL-4	Analyzing	PO1,PO4
7	What is beamforming?	BTL-1	Remembering	PO1,PO2
8	Define transmit precoding	BTL-1	Remembering	PO1,PO2
9	What are Beamforming techniques	BTL-3	Applying	PO1
10	. Define transmit diversity May/June 2016	BTL-1	Remembering	PO1
11	Define Spatial diversity? May/June 2017	BTL-1	Remembering	PO1
12	Define Pattern diversity? May/June 2017	BTL-1	Remembering	PO1,PO2,PO3
13	Define Polarization diversity	BTL-5	Evaluating	PO1,PO2,PO3, PO4

14	Define Transmit/Receive diversity	BTL-1	Remembering	PO1
15	Define ergodic capacity (Nov/Dec 2016)	BTL-1	Remembering	PO1
16	Define outage capacity (Nov/Dec 2016)	BTL-1	Remembering	PO1
17	Define capacity of a fading channel	BTL-2	Understanding	PO2
18	Why are smart antennas required?	BTL-1	Remembering	PO1,PO2
19	What is channel state information?	BTL-1	Remembering	PO1,PO2
20	What is Antenna Diversity? NOV/DEC 2015	BTL-2	Understanding	PO1,PO2
21	. What are smart antenna systems?	BTL-1	Remembering	PO1,PO2
22	What is precoding?	BTL-1	Remembering	PO1,PO2
23	What is adaptive beamforming?	BTL-2	Understanding	PO1,PO2,PO3
24	What is adaptive beamforming?	BTL-2	Understanding	PO1,PO2
25	What is diversity?	BTL-2	Understanding	PO1
26	Define STCM.	BTL-1	Remembering	PO1,PO2
27	Write the classification in space diversity reception method.	BTL-1	Remembering	PO1,PO3,PO4
28	What is MIMO system? May/June 2016	BTL-2	Understanding	PO2,PO3
29	Write down the expressions for probability of error for BPSK modulation techniques with coherent detection for the following cases NOV/DEC 2015	BTL-2	Understanding	PO1,PO2,PO4
30	What is MIMO system? May/June 2016	BTL-1	Remembering	PO1,PO4
PART-B&C				
1	With diagram explain the system model for MIMO systems. (Nov/Dec 2016)	BTL-2	Understanding	PO2,PO3,PO4
2	Discuss about the operation of spatial multiplexing systems. NOV/DEC 2015 , May/June 2016	BTL-2	Understanding	PO2,PO3
3	Explain the operation of transmit precoding and receiver precoding schemes	BTL-1	Remembering	PO2,PO3
4	Why is beam forming important for wireless systems. With illustration explain transmit beam forming, receive beam forming and opertunistic beamforming.	BTL-1	Remembering	PO2,PO4
5	Using diagrams explain transmit diversity and receive diversity	BTL-1	Remembering	PO3,PO4
6	Derive the channel capacity of a fading and non-fading channel for information transmitted from a wireless system. (Nov/Dec 2016)	BTL-1	Remembering	PO3,PO4
7	Derive the channel state information in wireless system.	BTL-1	Remembering	PO3,PO4
8	Explain in detail how inherent delay in a multiuser system is overcome by beam forming.	BTL-2	Understanding	PO2,PO3,PO4

UNIT I WIRELESS CHANNELS

Large scale path loss – Path loss models: Free Space and Two-Ray models -Link Budget design – Small scale fading- Parameters of mobile multipath channels – Time dispersion parameters Coherence bandwidth – Doppler spread & Coherence time, Fading due to Multipath time delay spread – flat fading – frequency selective fading – Fading due to Doppler spread – fast fading – slow fading

PART – A

UNIT I: WIRELESS CHANNELS

1. What are the propagation mechanisms of EM waves?

The four propagation mechanisms of EM waves are

$$P_R(d) = P_T G_T G_R \left(\frac{\lambda}{4\pi d}\right)^2$$

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

2.What is the significance of propagation model? May/June 2017

The major significance of propagation model are:

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

3.What do you mean by small scale fading?

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

4.What are the factors influencing small scale fading? May/June 2017

The factors which influence small scale fading are:

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

5.When does large scale propagation occur?

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

6. Differentiate the propagation effects with mobile radio.

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

7. Define Doppler shift. (/Dec 2016)

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

$F_D = f_r - f_0 = -f_0V/C$ Where f_0 -> transmission frequency

f_r -> received frequency

8. Differentiate time selective and frequency selective channel.

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

9. Define coherence time NOV/DEC 2015

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

10. What do you mean by WSSUS channels?

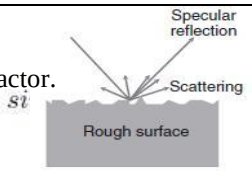
In multipath channels, the gain and phase shift at one delay are uncorrelated with another delay is known as uncorrelated scattering of WSSUS.

11. What is free space propagation model?

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

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

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



12.Define EIRP.

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

EIRP=P_tG_t

Where P_t-transmitted power in W

G_t-transmitting antenna gain

13. Explain path loss.

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

14. What is intrinsic impedance and Brewster angle? May/June 2016

Intrinsic impedance is defined by the ratio of electric to magnetic field for a uniform plane wave in the particular medium.

Brewster angle is the angle at which no reflection occurs in the origin. Brewster angle is denoted by θ_B as shown below,

15. What is scattering?

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

16. Define radar cross section.

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

17. Name some of the outdoor propagation models?

Some of the commonly used outdoor propagation models are

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

18.Define indoor propagation models.

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

19. Mention some indoor propagation models?

Some of the indoor propagation models are:

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

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

Merits:

Accuracy in parameter prediction.

Suitable for modern land mobile radio system. Urban, suburban areas are analyzed. Demerits:

Rural areas are not analyzed. Analytical explanation is not enough.

21.List the advantages and disadvantages of Hata model?

Advantages: Suitable for large cell mobile system. Cell radius on the order of 1km is taken for analysis.

Disadvantages: Not suitable for PCS model. This model does not have any path specific correction.

22.What is the necessity of link budget?

The necessities of link budget are:

i. A link budget is the clearest and most intuitive way of computing the required Transmitter power. It tabulates all equations that connect the Transmitter power to the received SNR
ii. It is reliable for communications.
iii. It is used to ensure the sufficient receiver power is available.
iv. To meet the SNR requirement link budget is calculated

23. Find the far field distance for an antenna with maximum dimension of 2 m and operating frequency of 1 GHz

Solution: Since the operating frequency f = 1GHz

The wavelength $\lambda = (3 \times 10^8 m/s)/(1 \times 10^9 Hz)$ m .=0.3m

Thus, with the largest dimension of the antenna, D=1m,

the far field distance is $Df = 2D^2/\lambda = 2(1)2/0.3 = 6.67m$

24.Define Coherence Bandwidth? NOV/DEC 2015, May/June 2016
Coherence bandwidth is a statistical measure of the range of frequencies over which the channel can be considered flat

25.What is Slow fading?It occurs when the large reflectors and diffracting objects along the transmission paths are distant from the terminal.

26. State the propagation effects in mobile radio

The type of fading experienced by a signal propagating through a mobile communication channel depends on the nature of the transmitted signal with respect to the characteristics of the wireless channel. Fading effets in a mobile environment can be classified as 1. Fading effects due to multiple path time delay spread. 2. Fading effects due to Doppler spread.

27. What are the different fading effects due to Doppler spread?

Fast fading and Slow fading

28. Write the effects of fading.

1. Rapid changes in signal strength over a small travel distance or time interval.

2. Random frequency modulation due to varying Doppler shifts on different multipath signals

3. Time dispersion caused by multipath propagation delays.

29. What is fading and Doppler spread?

In wireless communications, fading is deviation of the attenuation affecting a signal over certain propagation media. The fading may vary with time, geographical position or radio frequency, and is often modelled as a random process. A fading channel is a communication channel comprising fading. The coherence time of the channel is related to a quantity known as the Doppler spread of the channel. When a user (or reflectors in its environment) is moving, the user's velocity causes a shift in the frequency of the signal transmitted along each signal path. This phenomenon is known as the Doppler shift.

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

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. Find the far field distance for an antenna with maximum dimension of 2 m and operating frequency of 1 GHz

NOV/DEC 2015

Solution: Since the operating frequency f = 1GHz

The wavelength $\lambda = (3 \times 10^8 m/s)/(1 \times 10^9 Hz)$ m .=0.3m

Thus, with the largest dimension of the antenna, D=1m,

the far field distance is $df = 2D^2/\lambda = 2(1)2/0.3 = 6.67m$

PART-B

1. Explain two-ray ground reflection model in detail (Nov/Dec 2016)

   Ref Wireless communication by Theodore S Rappaport page No: 85-90

2. Explain Fast fading and slow fading in detail

   Ref Wireless communication by Theodore S Rappaport page No: 170-172

3. Explain free space propagation model and explain the parameters of mobile multipath channel . May/June 2016

   Ref Wireless communication by Theodore S Rappaport page No: 85-90

4. Explain link budget design in detail

   Ref Wireless communication by Theodore S Rappaport page No: 102-109

5. Explain Flat fading and frequency selective fading in detail

   Ref Wireless communication by Theodore S Rappaport page No: 166-170

6. Explain the different parameters of mobile multipath channel. May/June 2016

   Ref Wireless communication by Theodore S Rappaport page No: 159-165

7.a) i) Explain the advantages and disadvantages of the two ray ground reflection model in the analysis of path loss

ii) In the following cases tell whether the two ray model could be applied and justify why or why not

Case (i) : h_1=35m, h_r=3m, d=250 m

case (ii) : h_1=30m, h_r=1.5m, d=450 m

iii) Prove that in the two tray ground reflection model $d = d'' - d' = 2h_t h_r/d$

b)Derive the impulse response model of a multipath channel and also obtain the relationship between Bandwidth and received power

Refer Wireless communication, Rappaport Pg.No: 181 NOV/DEC 2015

8. Explain the fading effects due to multipath time delays spread and fading effects due to doppler spread. (Nov/Dec 2016)

Ref Wireless communication by Theodore S Rappaport page No: 92-97.

UNIT-II: CELLULAR ARCHITECTURE

PART A

1. What is meant by frequency reuse?

   Frequency reuse is the process of using the same radio frequencies on radio transmitter sites within a geographic area that are separated by sufficient distance to cause minimal interference with each other
2. What is TDMA

   Frequency division multiple access (FDMA) assigns individual channels to individual users. It can be seen that each user is allocated a unique frequency band or channel. These channels are assigned on demand to users who request service. During the period of the call, no other user can share the same channel
3. Define co channel reuse ratio. NOV/DEC 2015

   It is define as the ratio between the distance between the centers of nearest co channel cells to the radius of the cell. Q = D/R
4. Types of channel Assignment
   - Fixed channel assignment
   - Dynamic channel assignment
5. what is fixed channel assignment? May/June 2017

   In a fixed channel assignment strategy, each cell is allocated a predetermined set of voice channels. Any call attempt within the cell can only be served by the unused channels in that particular cell. If all the channels in that cell are occupied, the call is *blocked* and the subscriber does not receive service
6. Define MS, BS and MSC.

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

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

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

   A handoff refers to the process of transferring an active call or data session from one cell in a cellular network to another or from one channel in a cell to another. A well-implemented handoff is important for delivering uninterrupted service to a caller or data session user
8. Define co channel interference. ? May/June 2017

   The interference between the signals from co channel cells is called as co cannel interference
9. Define grade of service. (NOV/DEC 2015) (NOV/DEC 2016)

   Grade of service is defined as the measure of the ability of a user to access a trunked system during the busiest hour.
10. What is adjacent channel interference.

    Interference resulting from signals which are adjacent in frequency to the desired signal is called adjacent channel interference
11. What is dynamic channel assignment?

    If the voice channels are not allocated permanently in a cell, it will be called as dynamic channel assignment. In a dynamic channel assignment strategy, voice channels are not allocated to different cells permanently. Instead, each time a call request is made, the serving base station requests a channel from the MSC .In this assignment, channels are dynamically allocated to users by the MSC
12. what are the different modes(or strategies) of hand-off.
    - MCHO – Mobile Controlled Hand off
    - NCHO – Network Controlled Hand off
    - MAHO – Mobile Assisted Hand off
13. Define hard hand off?

    In Hard hand off – Mobile monitors BS and new cell is allocated to a call with strong signal.

    a Hard handoff (or Hard handover) is a typical Handoff mechanism in a communication network which is designed to work by first breaking off from the initial connection with a base station before switching to another base station

14. Define soft hand off? May/June 2016

In Soft hand off – MS with 2 or more calls at the same time and find which is the strongest signal BS, the MSC automatically transfers the call to that BS.

15. Define cell and cluster

Cellular radio systems rely on an intelligent allocation and reuse of channels throughout a coverage region. Each cellular base station is allocated a group of radio channels to be used within a small geographic area called a *cell*. Base stations in adjacent cells are assigned channel groups which contain completely different channels than neighbouring cells.

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

16. What is CDMA?

In *code division multiple access* (CDMA) systems, the narrowband message signal is multiplied by a very large bandwidth signal called the *spreading signal*. The spreading signal is a pseudo-noise code sequence that has a chip rate which is orders of magnitudes greater than the data rate of the message. All users in a CDMA system use the same carrier frequency and may transmit simultaneously. Each user has its own pseudorandom codeword which is approximately orthogonal to all other code words

17. What is dwell time and what are the factor it depends on?

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

18. Define foot print

Actual radio coverage of a cell is called as footprint. It is determined from the field measurements or propagation prediction models

19. What are the techniques to improve the capacity of cellular system

Techniques used to improve capacity

- Cell splitting
- Sectoring
- Zone microcell concept or coverage zone approaches

20. Why shape of the cell is chosen as hexagon?

when considering geometric shapes which cover an entire region without overlap and with equal area, there are three sensible choices—a square, an equilateral triangle, and a hexagon. A cell must be designed to serve the weakest mobiles within the footprint, and these are typically located at the edge of the cell.

For a given distance between the center of a polygon and its farthest perimeter points, the hexagon has the largest area of the three. Thus, by using the hexagon geometry, the fewest number of cells can cover a geographic region, and the hexagon closely approximates a circular radiation pattern which would occur for an omni-directional base station antenna and free space propagation.

21. Define cell splitting

Cell splitting is the process of subdividing a congested cell into smaller cells, each with its own base station and a corresponding reduction in antenna height and transmitter power. Cell splitting increases the capacity of a cellular system since it increases the number of times that channels are reused.

22.State the principles of CDMA.

Principles of CDMA:

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

23. How the capacity can be increased in CDMA?

Capacity in CDMA can be increased by

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

24. What do you mean by spread spectrum?

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

25. What is PN sequence?

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

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

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

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

Properties of PN sequence are:

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

28. What are the advantages and disadvantages of FDMA?

Advantages: The transmitter and receiver require much less digital signal processing, Synchronization is simple.

Disadvantages: 1. Sensitivity to fading 2. Sensitivity to random frequency modulation 3. Inter modulation

29. State advantages of CDMA over FDMA. (NOV/DEC 2016)

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

30. Define self-jamming problem in CDMA.

Self-jamming is a problem in CDMA system. Self-jamming arises from the fact that the spreading sequences of different users are not exactly orthogonal, hence in the dispreading of a particular PN code, non-zero contributions to the receiver decision statistic for a desired user arise from the transmissions of other users in the system

31. Write the advantages of micro cell concept.

(i) The co-channel interference in the cellular system is reduced since a large central base station is replaced by several lower powered transmitters (zone transmitters) on the edge of the cell. (ii) Decreased co-channel interference improves the signal quality. (iii) It will increase the channel capacity without the degradation in trunking efficiency caused by sectoring.

32. Write the drawbacks of sectoring.

(i) Each sector is nothing but a new cell with a different shape, because channels have to be partitioned between the different sectors of a cell. (ii) The network load is substantially increased because a handoff has to be made each time a mobile terminal moves from one sector of a cell to another.

33. What is multiple access technique? May/June 2016

Multiple Access Techniques are ways to access a single channel by multiple users. They provide multiple access to the channel. A "channel" refers to a system resource allocated to a given mobile user enabling the user to establish communication with the network (other users). Based on the type of channel, we can use a particular multiple access technique for communication.

PART-B&C

1. With the help of a neat diagram explain about frequency reuse and the advantages of it.

ANS: Refer section 3.2 in Wireless communication, Rappaport Pg.No: 58

Diagram
Derivation for N=3, 7 and 12
The advantages of frequency reuse

2.Give the difference between FDMA and TDMA.

ANS : Refer section 17.2 in Wireless communication, Andreas f molisch pg.no:449-455

3. Explain the different techniques of improving coverage and capacity in Cellular System.

ANS : Refer section 3.7 in Wireless communication, Rappaport Pg.No:86 - 93 4.

4. Explain in detail about reverse CDMA channel.

ANS: Refer section 11.4.3 in Wireless communication, Rappaport Pg.No: 458

5.Compare and contrast the features of FDMA, TDMA and CDMA

ANS: Comparison based on Bandwidth, Security, Efficiency

ANS: Refer section 9.1.1 in Wireless communication, Rappaport Pg.No: 449-459

6. With neat diagram explain the forward CDMA channel Structure

ANS: Frequency Hopping, Explanation, Direct Sequence

ANS: Refer section 11.4.2 in Wireless communication, Rappaport Pg.No: 458

7.Summarise the features of various multiple access techniques used in wireless mobile communication. State the advantages and disadvantages of each techniques. May/June 2016

Refer section 11.4.2 in Wireless communication, Rappaport Pg.No: 449-460

8. Explain about co-channel interference and adjacent channel interference. Describe the technique to avoid interference. (NOV/DEC 2016)

Refer section 9.1.1 in Wireless communication, Rappaport Pg.No: 452-465.

9. (i) Explain in detail how frequency is efficiently allocated in an cellular radio systems. (NOV/DEC 16)

(ii) Explain in detail a handoff scenario at cell boundary. (NOV/DEC 2016)

Refer section 3.7 in Wireless communication, Rappaport Pg.No:86 - 94.

UNIT-III: DIGITAL SIGNALING FOR FADING CHANNELS

PART-A

1. State the difference between MSK and GMSK (Nov/Dec 2009).

   Minimum shift keying (MSK) is a special type of continuous phase-frequency shift keying. (CPFSK) with modulation index h=0.5. A modulation index of 0.5 corresponds to the minimum frequency spacing.

   Gaussian Minimum Shift Keying, or to give it its full title Gaussian filtered Minimum Shift Keying, GMSK, is a form of modulation used in a variety of digital radio communications systems. It has advantages of being able to carry digital modulation while still using the spectrum efficiently.

   GMSK modulation is based on MSK, which is itself a form of phase shift keying. One of the problems with standard forms of Phase Shift Keying (PSK) is that sidebands extend out from the carrier. To overcome this, MSK and its derivative GMSK can be used.

   The difference between this two is,GMSK uses a Gaussian pulse shaping filter prior to MSK

2. State the types of modulation schemes used in mobile communication. (Nov/Dec 2009).
   - QPSK-Quadrature Phase Shift Keying
   - MSK-Minimum Shift Keying
   - GMSK-Gaussian Minimum Shift Keying
3. Define Power efficiency. (May/June 2012)

   It describes the ability of the modulation scheme to preserve the fidelity of the digital message at low power levels.

4. State the advantage of using GMSK rather than MSK. (Apr/May 2010)

   The bandwidth occupied by GMSK modulated signal is less in comparison to MSK modulated signal

5. What is CPFSK? (Nov/Dec 2010)

   Continuous-phase frequency-shift keying (CP-FSK) is binary FSK except the mark and space frequencies are synchronized with the input binary bit rate. Synchronous simply implies that there is a precise time relationship between the two; it does not mean they are equal. With CP-FSK, the mark and space frequencies are selected such that they are separated from the center frequency by an exact multiple of one-half the bit rate

6. What is a diversity receiver? (Nov/Dec 2013)

   Diversity receiver is the diversity scheme applied at the receiver end of the antenna in all effective technique for reducing interference, where selective combiner is used to combine two-correlated signal.

7. State the different types of line coding. (Nov/Dec 2014)
   - Block codes
   - Convolutional codes
8. Rayleigh distribution is widely used in wireless communications? Why? Give any two reasons.

NOV/DEC2008)

The Rayleigh distribution is widely used in wireless communications. This is due to several reasons:

•It is an excellent approximation in a large number of practical scenarios, as confirmed by amultitude of measurements. However, it is noteworthy that there are scenarios here it is notvalid. These can occur, e.g., in Line Of Sight (LOS) scenarios, some indoor scenarios, and in(ultra) wideband scenarios

•It describes a worst case scenario in the sense that there is no dominant signal component, andthus there is a large number of fading dips. Such a worst case assumption is useful for the designof robust systems.

•It depends only on a single parameter, the mean received power – once this parameter is known, the complete signal statistics are known. It is easier, and less error-prone, to obtain this single parameter either from measurements or deterministic prediction methods than to obtain the multiple parameters of more involved channel models.

•Mathematical convenience: computations of error probabilities and other parameters can oftenbe done in closed form when the field strength distribution is Rayleigh.

9. What is coherent detector? (May/June 2013)

Coherent systems need carrier phase information at the receiver and they use

matched filters to detect and decide what data was sent

10. Define absolute bandwidth? (April/May 2010).

The term absolute bandwidth B denotes the width of the frequency interval occupied by a signal's spectrum, which ranges from a lower cutoff frequency to an upper cutoff frequency.

11. What is cyclic prefix? (Nov/Dec 2014) (Nov/Dec 2016)

In telecommunications, the term cyclic prefix refers to the prefixing of a symbol with a repetition of the end.The cyclic prefix serves two purposes.

- As a guard interval, it eliminates the inter symbol interference from the previous symbol.
- As a repetition of the end of the symbol, it allows the linear convolution of a frequency-selective multipath channel to be modelled as circular convolution, which in turn may be transformed to the frequency domain using a discrete Fourier transform. This approach allows for simple frequency-domain processing, such as channel estimation and equalization.

12. Write short notes on OFDM. (May/June 2012).

Orthogonal Frequency Division Multiplexing, an FDM modulation technique for transmitting large amounts of digital data over a radio wave. OFDM works by splitting the radio signal into multiple smaller sub-signals that are then transmitted simultaneously at different frequencies to the receiver

13. Give some examples of linear modulation. ? May/June 2017

Pulse shaped QPSK

OQPSK

14. Mention some merits of MSK. (Nov/Dec 2011)

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

15. What is the need of Gaussian filter? (Nov/Dec 2016)

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

less bandwidth than conventional FSK

16. Define non linear modulation. (Nov/Dec 2009)

    In the nonlinear modulation the amplitude of the carrier is constant, regardless of the variation in the modulating signals. On-linear modulations may have either linear or constant envelopes depending on whether or not the baseband waveform is pulse shaped.

17. Define QPSK(Nov/Dec 2011)

    QPSK is a multilevel modulation in which four phase shifts are used for representing four different symbols

18. Define QAM(Nov/Dec 2007)

    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". Here both the amplitude and phase of the carrier signal is varied with respect to information signal

19. Define M-ary transmission system?(April/May 2010).

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

20. What are the techniques used to improve the received signal quality?
    - Equalization
    - Diversity
    - Channel coding

21. Write the applications of MFSK and OFDM

    They are used for high speed data connections as part of the IEEE 802.11a standards activities to provide 54mbps WLAN connections, as well as for high speed line of sight and non line of sight connections for Multi channel Multipoint Distribution service (MMDS) operation.

22. Mention any two criteria for choosing a modulation technique for a specific wireless application?

    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 are the main features of QPSK? (June 2014)
    - Very low modulation losses.
    - Baseband signal processing section fully configurable.
    - Internal carrier generation
    - Architectures featuring direct carrier modulation or intermediate carrier modulation
    - with frequency up-conversion
    - Cold internal redundant configurations for increased reliability

24. List the advantages of GMSK. (Dec 2014)

    GMSK modulation has improved spectral efficiency when compared to other phase shift keyed modes. It can be amplified by a non-linear amplifier and remain undistorted. In GMSK modulation none of the information is carried as amplitude variations. This means that is immune to amplitude variations and therefore more resilient to noise.

25. State the advantages of offset-QPSK. (Dec 2014)

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

26. What are the modulations suitable for frequency selective mobile channels?

    Both filtered and unfiltered BPSK, QPSK, OQPSK and MSK modulations are suitable.

27. Why MSK cannot be directly used in multi user communications?(Dec 2012)

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

2.Slow decay of MSK power spectral density curve creates adjacent channel interference. Hence MSK cannot be used for multiuser communications..

28. Write the advantages of digital over analog modulation.

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

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

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

30. What is linear modulation and non linear modulation?

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

31.Find the 3-dB bandwidth for a Gaussian low pass filter to produce 0.25 GMSK with a

channel data rate of R_b=300 kbps NOV/DEC 2015

From the problem statement it is clear that T = 1/Rb = 1/300 * 10^3=3.33μsec Solving for B where BT = 0.25, B = 0.25/T = 75.08kHz Thus the 3 - dB bandwidth is 75.08kHz.

32.An 900 MHz carrier signal is frequency modulated using a 100 kHz sinusoidal modulating waveform. The peak deviation of the FM signal is 500 kHz. If this FM signal is received by a super heterodyne receiver having an IF frequency of MHz, determine the IF bandwidth necessary to pass the signal NOV/DEC 2015

From the problem

Modulating signal frequency f_m=100kHz

Peak frequency deviation Δf=500KHz

By Carson rule Bandwidth =2(Δf+f_m)

=2(500+100)kHz

=1200kHz

33. Why is MSK referred to as fast FSK? May/June 2016

MSK is sometimes refered to as fast FSK, as the frequency spacing used is only half as that used in conventional noncoherent FSK.

MSK is a spectrally efficient modulation scheme and is particularly attractive for use in mobile radio communication systems. It possesses properties such as constant envelope, spectral effiency, good BER performance, and self-synchronizing capability

34.What is windowing? May/June 2016

Windowing is a technique proposed to help reduce sensitivity to frequency offers in an OFDM systems. This process involves cylindrically extending the time domain signal associated with each symbol by samples. The resulting signal is then shaped with window function.

PART – B&C

1. a) Explain the concept of minimum shift keying and Gaussion MSK. (8)

b)How MSK signals are generated? Discuss in detail the demodulation techniquesfor MSK.(12) (Apr/May2015). (Nov/Dec 2016)

ANS: Refer section 6.9 in Wireless communication, Rappaport Pg.No:314-320

2. Give a detailed description of OFDM transceiver. (Apr/May2015). (Nov/Dec 2016)

ANS: Refer section 6.10 in Wireless communication, Rappaport Pg.No:328

3. (a)Describe with block diagram Offset-QPSK and its advantages.

ANS: Refer section 6.85 in Wireless communication, Rappaport Pg.No:303

(b)Explain the concept of GMSK and mention its advantages (May/June 2012) May/June 2016

ANS: Refer section 6.9 in Wireless communication, Rappaport Pg.No:318

4. Explain the principle of Pi/4 Differential QPSK from signal space diagram

(May/June 2013) May/June 2016

ANS: Refer section 6.12 in Wireless communication, Rappaport Pg.No:346

5. Derive the expression for probability of error in flat – fading channels(May/June 2013)

ANS: Refer section 7.10 in Wireless communication, Rappaport Pg.No:339

6.Briefly Explain the structure of wireless communication Link. (Nov/Dec2012.)

Refer Wireless communication, Andreas f molisch pg.no:181

UNIT IV MULTIPATH MITIGATION TECHNIQUES

Part-A

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

Techniques such as,

- Equalization
- Diversity
- Channel coding

are used to improve the received signal quality.

2. What is the need of equalization? ? May/June 2017

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

3. What is diversity? ? May/June 2017

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

4. Define spatial diversity. ? May/June 2017

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

5. Define STCM.

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

6. Define adaptive equalization? May/June 2016

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

7. Define training mode in an adaptive equalizer?

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

8. What is tracking mode in an adaptive equalizer?

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

9. Write a short note on linear equalizers and non linear equalizers? (Nov/Dec 2016)

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

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

10. Why non linear equalizers are preferred?

The linear equalizers are very effective in equalizing channels where ISI is not severe.The severity of the ISI is directly related to the spectral characteristics. In this case that there are spectral noise in the transfer function of the effective channel, the additive noise at the receiver input will be dramatically enhanced by the linear equalizer. To overcome this problem non linear equalizers are used.

11.What are the nonlinear equalization methods used?

Commonly used non linear equalization methods are:

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

12.What are the factors used in adaptive algorithms?

Rate of convergence ,Mis adjustments &Computational complexity

13.Define diversity concept.

If one radio path undergoes a deep fade, another independent path may have a strong signal. By having more than one path to select from, both the instantaneous and average SNRs at the receiver may be improved often by as much as 20dB to 30dB. The principle of diversity is to ensure that the same information reaches the receiver on statistically independent channels.

14. How the link performance can be improved?

Link performance can be improved by various techniques such as

i. Equalization
ii. Diversity
iii. Channel coding

15.Why diversity and equalization techniques are used?

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

16.What is diversity?

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

17.Differentiate selection diversity and combining diversity.

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

18. Define Switched Diversity

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

19. Define feedback or scanning diversity.

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

20. Define temporal diversity.

Wireless propagation channel is time variant, so for sufficient decorrelation, the temporal distance between

antennas must be atleast the half of maximum Doppler frequency.

21.What is meant by frequency diversity?

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

22.Differentiate micro and macro diversity.

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

23.What is transmit diversity?

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

24.What is an equalizer?

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

25.What is linear and non-linear equalizer?

Linear equalizer: the current and past values of the received signal are linearly weighted by the filter coefficients and summed to produce the output. No feedback path is used. Simple and easy to implement. Not suitable for severely distorted channel. Noise power signal is enhanced.

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

26. What is linear and non-linear equalizer? (Nov/Dec 2007)

In linear equalizer current and past values of the received signal are linearly weighted by the filter coefficient and summed to produce the output

If the output d(t) is not used in the feedback path to adapt the equalizer, the type of equalizers is called linear equalizer. If the output d(t) is feedback to change the subsequent outputs of the equalizer,the type of equalizers is called non-linear equalizer

27. What is transmit diversity? (May/June 2013)

Transmit diversity is radio communication using signals that originate from two or more independent sources that have been modulated with identical information-bearing signals and that may vary in their transmission characteristics at any given instant.

28. Differentiate micro and macro diversity. (Nov/Dec 2011) (Nov/Dec 2016)

The basic principle of diversity is that the RX has multiple copies of the transmit signal, where each of the copies goes through a statistically independent channel.This section describes different ways of obtaining these statistically independent copies. The methods that can be used to combat small-scale fading, are therefore called “micro diversity.”

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

29.Why diversity and equalization techniques are used? (May/June2008)

The three techniques of equalization, diversity, and channel coding are used to improve radio link performance

30.What are the nonlinear equalization methods used? (Nov/Dec 2010)

- Decision feedback equalization
- Maximum likelihood symbol detection
- Maximum likelihood sequence estimation

31. What are the benefits of RAKE receiver? May/June 2016

The main advantage of Rake Receiver is that it improves the SNR (or Eb / No). Naturally, this improvement is observed in larger environments with many multipaths than in environments without obstruction.

32. If a digital processing chip can perform one million multiplications per second. Determine the time required between each iteration for the following adaptive equalizer algorithm NOV/DEC 2015

Let N denote the number of coefficients in the equalizer and M the time required between each iteration

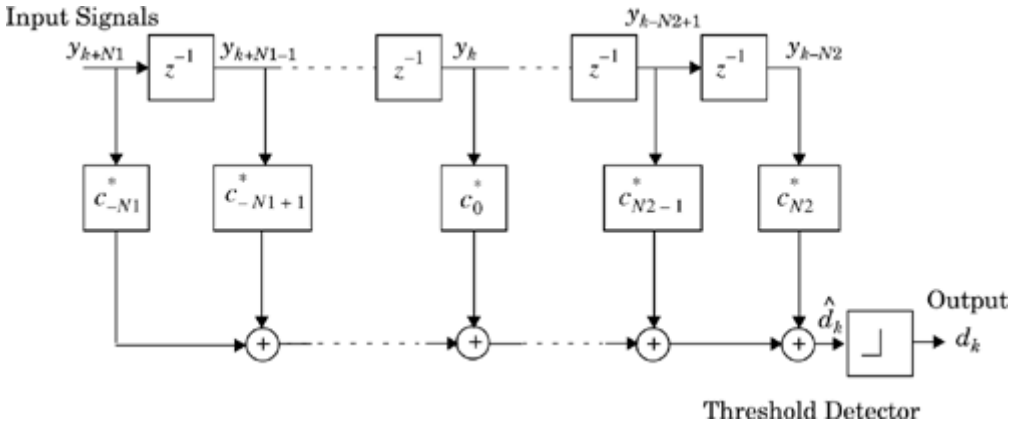
a) Square root RLS DFE

$M=1.5N^2+6.5N$ μs

b) Gradient lattice DFE

$M=13N-8$ μs

33.Draw the structure of Linear transversal equalizer NOV/DEC 2015



PART-B&C

1.Write short notes on : May/June 2016

(v) Spatial diversity

(vi) Frequency diversity

(vii) Polarization diversity

(viii) Time diversity

ANS: Refer section 7.11 in Wireless communication, Rappaport Pg.No:381- 390

2.With a diagram explain the performance of RAKE receiver? (Nov/Dec 2016)

ANS: Refer section 7.11 in Wireless communication, Rappaport Pg.No: 391 -392.

3.Enumerate the fundamental of equalization and reduction in intersymbol interference in communication channels.

ANS: Refer section 7.2 in Wireless communication, Rappaport Pg.No: 356-359

4.What is the non linear equalization? Explain the three non linear methods of Equalization with Suitable diagrams? May/June 2016

ANS: Refer section 7.7 in Wireless communication, Rappaport Pg.No:368-371

5. Enumerate the algorithm of adaptive equalization and explain. (Nov/Dec 2016)

ANS: Refer section 7.8 in Wireless communication, Rappaport Pg.No:372-379

6. Briefly explain Diversity combining techniques.

ANS: Refer section 7.10 in Wireless communication, Rappaport Pg.No:380-390

7.Explain in detail about linear and non linear equalization. May/June 2016

ANS: Refer section 7.7 in Wireless communication, Rappaport Pg.No:366-371

8. Consider a single branch Raleigh fading signal has a 20% chance of being 6dB below some mean SNR threshold

(i) Determine the mean of the Raleigh fading signal referenced to the threshold

Since $-6dB = \frac{1}{4}$, $Pr\{\gamma_i \leqslant \frac{\nu}{4}\} = 1 - e^{-\frac{\nu/4}{\Gamma}} = 0.2$, where ν is the SNR threshold, we hav

$$\frac{\nu}{4\Gamma} = -\log 0.8 \Rightarrow \frac{\Gamma}{\nu} = \frac{1}{-4\log 0.8} \approx 1.12 \approx 0.5dB$$

Therefore, the mean SNR of the Rayleigh fading signal is $0.5dB$ above the SNR threshol

(ii) Find the likelihood that a two branch selection diversity receiver will be 6dB below the mean SNR threshold

$P = \left(1 - e^{-\frac{1}{4\times\frac{\Gamma}{\nu}}}\right)^M$, where $\frac{\Gamma}{\nu} = 1.12$ from (a). Therefore, $P = 0.1993 \approx$

$P_2(6dB \text{ below the mean SNR threshold }) = 0.2^2 = 0.04$

(iii) Find the likelihood that a three branch selection diversity receiver will be 6dB below the mean SNR threshold

$$P_3(6dB \text{ below the mean SNR threshold }) = 0.2^3 = 0.008$$

(iv) Find the likelihood that a four branch selection diversity receiver will be 6dB below the mean SNR threshold

$$P_4(6dB \text{ below the mean SNR threshold }) = 0.2^4 = 0.0016$$

(v) Based on your answers above, is there a law of diminishing returns when diversity is used?

Yes. When there are more branches (i.e. M is larger), the improvement of the diversity gai is more and more small.

9. Derive the mean square error for a Generic Adaptive Equalizer

ANS: Refer section 7.7 in Wireless communication, Rappaport Pg.No:359-363

UNIT V: MULTIPLE ANTENNA TECHNIQUES

Part-A

1.Why need MIMO system?

The wireless system before MIMO is been constrained by network capacity which is related with channel quality and coverage. To see how problem occurred, we need to talk about the transmission on a multipath channel. In wireless communication the propagation channel is characterized by multipath propagation due to scattering on different obstacle.

The multipath problem is a typical issue in communication system with time variations and time spread. For time variations the channel is fading and caused SNR variations. For time spread, it becomes important for suitable frequency selectivity.

2.What are the Types of MIMO System? May/June 2017

There are two major classifications to determine types of MIMO:

(1) Single User MIMO (SU-MIMO) vs. Multi User MIMO (MU-MIMO)
(2) Open loop MIMO vs. Close loop MIMO

3.What is Single User MIMO (SU-MIMO): ? May/June 2017

When the data rate is to be increased for a single UE, this is called Single User MIMO(SU-MIMO).

4.What is Multi User MIMO (MU-MIMO):

When the individual streams are assigned to various users, this is called Multi UserMIMO (MU-MIMO). This mode is particularly useful in the uplink because the complexity on the UE side can be kept at a minimum by using only one transmit antenna. This is also called collaborative MIMO'.

5.What is Space Time Transmit Diversity (STTD) MIMO

Space-time block coding based transmit diversity (STTD) is a method of transmit diversity used in UMTSS third-generation cellular systems. STTD is optional in the UTRANN air interface but mandatory for user equipment. STTD utilizes space-time block code (STBC) in order to exploit redundancy in multiply transmitted versions of a signal. The same data is coded and transmitted through different antennas, which effectively doubles the power in the channel. This improves Signal Noise Ratio (SNR) for cell edge performance.

6. What is Spatial Multiplexing (SM) MIMO (Nov/Dec 2016)

Spatial multiplexing is transmission techniques in MIMO wireless communication to transmit independent and separately encoded data signals, so-called streams, from each of the multiple transmit antennas. Therefore, the space dimension is reused, or multiplexed, more than one time. SM delivers parallel streams of data to CPE by exploiting multi-path. It can double (2x2 MIMO) or quadruple (4x4) capacity and throughput.SM gives higher capacity when RF conditions are favorable andusers are closer to the BTS.

7. What is beamforming?

Beamforming or spatial filtering is a signal processing technique used in sensor arrays for directional signal transmission or reception.[1] This is achieved by combining elements in a phased array in such a way that signals at particular angles experience constructive interference while others experience destructive interference. Beamforming can be used at both the transmitting and receiving ends in order to achieve spatial selectivity. The improvement compared with omnidirectional reception/transmission is known as the receive/transmit gain (or loss).

8.Define transmit precoding

Precoding is a generalization of beam forming to support multi-stream (or multi-layer) transmission in multi-antenna wireless communications. In conventional single-stream beamforming, 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 beam forming cannot simultaneously maximize the signal level at all of the receive antennas. In order to maximize the throughput in multiple receive antenna systems, multi-stream transmission is generally required.

9. What are Beamforming techniques

Beamforming techniques can be broadly divided into two categories:

- conventional (fixed or switched beam) beamformers
- adaptive beamformers or phased array
- Desired signal maximization mode
- Interference signal minimization or cancellation mode

10. Define transmit diversity May/June 2016

Transmit diversity is radio communication using signals that originate from two or more independent sources that have been modulated with identical information-bearing signals and that may vary in their transmission characteristics at any given instant.

11. Define Spatial diversity? May/June 2017

Spatial diversity employs multiple antennas, usually with the same characteristics, that are physically separated from one another. Depending upon the expected incidence of the incoming signal, sometimes a space on the order of a wavelength is sufficient. Other times much larger distances are needed. Cellularization or sectorization, for example, is a spatial diversity scheme that can have antennas or base stations miles apart. This is especially beneficial for the mobile communication industry since it allows multiple users to share a limited communication spectrum and avoid co-channel interference.

12. Define Pattern diversity? May/June 2017

Pattern diversity consists of two or more co-located antennas with different radiation patterns. This type of diversity makes use of directive antennas that are usually physically separated by some (often short) distance. Collectively they are capable of discriminating a large portion of angle space and can provide a higher gain versus a single omnidirectional radiator.

13. Define Polarization diversity

Polarization diversity combines pairs of antennas with orthogonal polarizations (i.e. horizontal/vertical, ± slant 45°, Left-hand/Right-hand CP etc.). Reflected signals can undergo polarization changes depending on the medium through which they are travelling. A polarisation difference of 90° will result in an attenuation factor of up to 34dB in signal strength. By pairing two complementary polarizations, this scheme can immunize a system from polarization mismatches that would otherwise cause signal fade. Additionally, such diversity has proven valuable at radio and mobile communication base stations since it is less susceptible to the near random orientations of transmitting antennas.

14. Define Transmit/Receive diversity

Transmit/Receive diversity uses two separate, collocated antennas for transmit and receive functions. Such a configuration eliminates the need for a duplexer and can protect sensitive receiver components from the high power used in transmit.

15. Define ergodic capacity (Nov/Dec 2016)

This is the expected value of capacity (or) instantaneous capacity taken over all realizations of the channel.

16. Define outage capacity (Nov/Dec 2016)

This is the minimum transmission rate that is achieved over a certain fraction of time of 90-95%.

17. Define capacity of a fading channel

the capacity of a channel is given as $C=\log_2(1+\gamma IHI^2)$; where γ is the signal to noise ratio at the receiver; H is normalized transfer function from the transmitter to the receiver.

18. Why are smart antennas required?

1. Increasing coverage 2. increasing capacity 3. improving link quality

4. decrease delay dispersion 5. improvement of user position estimation.

19.What is channel state information

In wireless communications, channel state information (CSI) refers to known channel properties of a communication link. This information describes how a signal propagates from the transmitter to the receiver and represents the combined effect of, for example, scattering, fading, and power decay with distance.

20. What is Antenna Diversity? NOV/DEC 2015

Antenna Diversity is a transmission method using more than one antenna to receive or transmit signals along different propagation paths to compensate for multipath interferences.

21. What are smart antenna systems?

smart antennas (also known as adaptive array antennas, multiple antennas and, recently, MIMO) are antenna arrays with smart signal processing algorithms used to identify spatial signal signature such as the direction of arrival (DOA) of the signal, and use it to calculate beamforming vectors, to track and locate the antenna beam on the mobile/target. Smart antennas should not be confused with reconfigurable antennas, which have similar capabilities but are single element antennas and not antenna arrays

22.What is precoding?

Precoding is a generalization of beamforming to support multi-stream (or multi-layer) transmission in multi-antenna wireless communications. In conventional single-stream beamforming, 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 In order to maximize the throughput in multiple receive antenna systems, multi-stream transmission is generally required.

23. What is adaptive beamforming?

An adaptive beam former is a device that is able to separate signals co-located in the frequency band but separated in the spatial domain. This provides a means for separating the desired signal from interfering signals

24. List the different cases of CSI

i. Full CSI at the TX (CSIT) and full CSI at the RX (CSIR)
ii. Average CSIT and full CSIR
iii. No CSIT and full CSIR.
iv. Noisy CSI

25. What is diversity?

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

26. Define STCM.

Channel coding can also be combined with diversity (via multiple antennas) a technique called space-time coded modulation (STCM). The space-time coding is a bandwidth and power efficient method for wireless communication.

27. Write the classification in space diversity reception method.

Space diversity reception method can be classified into four categories. a) Selection Diversity b) Feedback diversity c) Maximal ratio combining and d) Equal gain diversity. (iv) Regular pulse excited(RPE)

28. What are the factors used in adaptive algorithms?

(i) Rate of convergence (ii) Misadjustment (iii) Computational complexity

29. What is MIMO system? May/June 2016

MIMO (multiple input, multiple output) is an antenna technology for wireless communications in which multiple antennas are used at both the source (transmitter) and the destination (receiver). The antennas at each end of the communications circuit are combined to minimize errors and optimize data speed. MIMO is one of several forms of smart antenna technology, the others being MISO (multiple input, single output) and SIMO (single input, multiple output).

30. Write down the expressions for probability of error for BPSK modulation techniques with coherent detection for the following cases NOV/DEC 2015

a) AWGN, b)Raleigh Fading

PART-B&C

1. With diagram explain the system model for MIMO systems. (Nov/Dec 2016)

ANS: Refer section 11.3.7 and 11.3.8 in Wireless communication, Andreas f molisch Pg.No:466

2. Discuss about the operation of spatial multiplexing systems. NOV/DEC 2015 , May/June 2016

ANS: Refer section 11.3.7 and 11.3.8 in Wireless communication, Andreas f molisch Pg.No:465

3. Explain the operation of transmit precoding and receiver precoding schemes

ANS: Refer section 11.3.7 and 11.3.8 in Wireless communication, Andreas f molisch Pg.No:492

4. Why is beam forming important for wireless systems. With illustration explain transmit beam forming, receive beam forming and opertunistic beamforming.

ANS: Refer section 11.3.7 and 11.3.8 in Wireless communication, Andreas f molisch Pg.No:462

5. Using diagrams explain transmit diversity and receive diversity.

ANS: Refer section 11.3.7 and 11.3.8 in Wireless communication, Andreas f molisch Pg.No:480

6. Derive the channel capacity of a fading and non-fading channel for information transmitted from a wireless system. (Nov/Dec 2016)

ANS: Refer section 11.3.7 and 11.3.8 in Wireless communication, Andreas f molisch Pg.No:470

7. Derive the channel state information in wireless system.

ANS: Refer section 11.3.7 and 11.3.8 in Wireless communication, Andreas f molisch Pg.No: 467

8. Explain in detail how inherent delay in a multiuser system is overcome by beam forming. May/June 2016

Refer ―Wireless Communications: Principles and Practice by T.S.Rappaport, Pg.No. 462

9.Explain with relevant diagrams the layered space time structure with respect to MIMO systems May/June 2016

Refer ―Wireless Communications: Principles and Practice by T.S.Rappaport, Pg.No. 476