POLITEKNIK MALAYSIA

TOPICAL PAST PAPERS WITH TOPIC SUMMARY

WIRELESS COMMUNICATION

C T SALWANIIEE ◆ ASLINDA

TOPICAL PAST PAPERS WITH TOPIC SUMMARY
WIRELESS
COMMUNICATION

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e ISBN 978-967-0047-45-4
9 789670 047454

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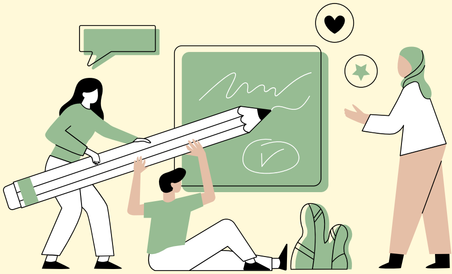

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PREFACE

The success and final outcome of this book required a lot of guidance and assistance from many people and we are extremely fortunate to have got this all along with the completion of our book.

There are no words that can be expressed for such generous support and guidance that utmostly has made this ebook become a reality in such a time and effort.

To all the individuals that have contributed, we would like to express our gratitude for being an inspiration and supporter through all the way of ups and downs including our families, peers and institution.

Without the experiences and assistance from all peers and teams, this book would have not existed. Tremendously thanks to all of you

SYNOPSIS

TOPICAL PAST PAPERS & TOPIC SUMMARY

This book contains a collection of past paper questions from the topics of Wireless Communication (DEP50063) course that is Wireless Communication System, Cellular Communication System, Concept of Cellular Communications, Radio Wave Propagation and Multiple Access Technique.

This book is designed to assist students review past final exam questions by collecting questions based on the topics in the course. At the beginning of each topic, a summary was included to strengthen the students' knowledge of the topic.

Now, let's embark on a journey to simplify your learning process and achieve your goals. Dive into the pages ahead and unlock the potential of 'Topical Past Year and Note Summary.' Your path to success starts here.

Study hard and good luck!

List of Abbreviation

WPAN .... Wireless Personal Area Network
WLAN .... Wireless Local Area Network
WiMAX .... Worldwide Interoperability for Microwave Access
WMAN .... Wireless Metropolitan Area Network
RFID .... Radio Frequency Identification
WWAN .... Wireless Wide Area Network
1G .... First Generation
2G .... Second Generation
3G .... Third Generation
4G .... Fourth Generation
5G .... Fifth Generation
GSM .... Global System for Mobile Communication
GPRS .... General Radio Packet Access
EDGE .... Enhance Data Rates for GSM Evolution
UMTS .... Universal Mobile Telecommunications System
HSDPA .... High Speed Downlink Packet Access
HSPA .... High Speed Packet Access
LTE .... Long Term Evolution
LTE - A .... Long Term Evolution Advanced
PSTN .... Public Switching Telephone Network
CCI .... Co Channel Interference
ACI .... Adjacent Channel Interference
RBS .... Radio Base Station
BTS .... Base Transceiver Station
SNR .... Signal to Noise Ratio
FDD .... Frequency Division Duplex
TDD .... Time Division Duplex
FDMA .... Frequency Division Multiple Access
TDMA .... Time Division Multiple Access
CDMA .... Code Division Multiple Access
OFDMA .... Orthogonal Frequency Division Multiple Access
OFDM .... Orthogonal Frequency Division Multiplexing

CHAPTER 1:

WIRELESS COMMUNICATION SYSTEMS

Wireless communication refers to the transfer of information or data between two or more devices without the need for physical connections or cables. This technology has revolutionized the way of communication. Advancements in wireless technology and ongoing research aim to address some of these limitations and improve the overall performance and reliability of wireless communication systems.

Wireless devices can be access through radio link between fixed and mobile wireless access. Fixed wireless communication refers to the transmission of data between fixed points or locations without the need for physical wires or cables. Mobile wireless communication, involves the transmission between mobile devices over a cellular network. It allows users to communicate and access the internet while on the move.

Wireless communication can be broadly categorized into several types based on the range, purpose, and technology used. The common categories are WPAN, WLAN ,WMAN and WWAN to cover cross cities, countries, or even continents using cellular network.

Bluetooth is a wireless communication technology that allows devices to connect and communicate over short distances. It operates in the 2.4 GHz frequency band and uses radio waves for data transmission. Bluetooth is commonly used for creating Personal Area Networks (PANs) and enables devices to exchange data, voice, and control information.

RFID is a technology that uses radio waves to wirelessly identify and track objects or individuals. It consists of two main components: RFID tags and RFID readers. RFID technology offers advantages such as automated data capture, real-time tracking, and reduced manual labor. However, it also has limitations, including tag readability issues in certain environments and the need for line-of-sight or close proximity between tags and readers, depending on the frequency used.

STRUCTURE QUESTION

SESSION: JUNE 2016

1. State THREE wireless communication categories. C1 (3M)

2. Describe the characteristic of a Wireless Personal Area Network (WPAN) in terms of coverage, applications and mobility. C1 (6M)

3. Bluetooth initiated on 1989 by Dr. Nil Rydbeck and Dr. Johan Ullman to develop short link radio technology. Define Bluetooth. C1 (3M)

4. Bluetooth have two types of network topology and one of them known as piconet. Describe the piconet topology. C2 (5M)

SESSION: DEC 2016

1. Identify THREE (3) differences between 802.11a and 802.11g in terms of operational frequency, maximum speed data rate and indoor range. C2 (6M)

2. Describe the differences between piconet and scatternet. C2 (6M)

3. Define RFID. C1 (3M)

SESSION: JUNE 2017

1. Define wireless communication. C1 (3M)

2. WPAN is one of wireless communication categories. Briefly explain WPAN. C2 (6M)

3. List THREE (3) applications of Bluetooth technology. C1 JUN17 (3M)

4. With an aid of a suitable diagram, describe the two types of Bluetooth network below: C2 JUN17 (5M)
   i. Piconet
   ii. Scatternet

SESSION: DEC 2017

1. With the aid of a suitable diagram, identify the categories of wireless communication with an example for each category. C2 (6M)

2. Identify the specifications of the Bluetooth system in terms of frequency band, radio transmit power and distance range. C1 (3M)

3. Illustrate the operation of an active RFID system by using an appropriate diagram. C3 (7M)

SESSION: JUNE 2018

1. Define Bluetooth technology. C1 (3M)

2. Wireless Local Area Network (WLAN) is one of the categories of wireless communication. Briefly explain WLAN features. C1 (6M)

SESSION: DEC 2018

1. State the IEEE standard related to WPAN, WLAN and WMAN. C1 (3M)

2. List THREE (3) applications of Bluetooth technology. C1 (3M)

3. Illustrate each component for Radio Frequency Identification (RFID) by using a suitable diagram. C3 (7M)

SESSION: JUNE 2019

1. Identify the characteristics of wireless communication. C1 (4M)

2. Explain THREE (3) advantages and THREE (3) disadvantages of wireless communication system. C2 (6M)

3. RFID is one of the WPAN applications. Write the operation of an active RFID system by using an appropriate diagram. C3 (10M)

SESSION II: 21/22

1. Touch 'n Go smart card used at the Malaysian toll expressway and highway uses Radio Frequency Identification (RFID) contactless smart card technology. Examine the types of RFID used in the card with reasonable statement and sketch the basic operation of RFID for the use in the automated toll collection. C3 (10M)

SESSION I: 22/23

1. Fixed and mobile wireless are two technologies that look similar but differ in small yet important ways. Explain about fixed and mobile wireless network technologies. C2 (4M)

2. RFID uses electromagnetic fields to automatically identify and track tags attached to objects. Demonstrate the basic operation of RFID process in order to identify an object. C3 (12M)

SESSION II: 22/23

1. Explain WPAN, its function with examples. (5M)

2. Implement the basic operation for semi-active RFID with the aid of a diagram. (10M)

EXTRA

1. Bluetooth wireless technology is a short-range radio technology with 2 types of topology. With explanation sketch the relation of these two types network topology.

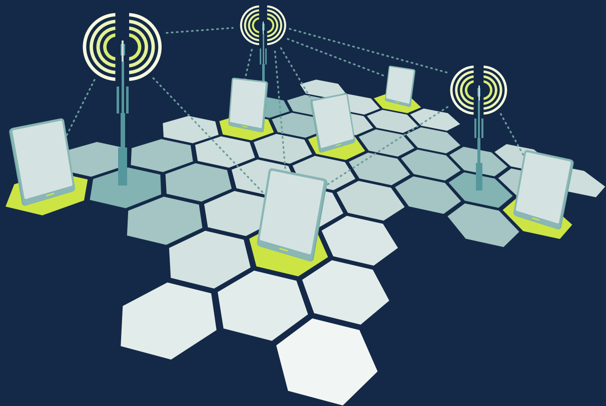
ESSAY QUESTION

SESSION: JUNE 2018

The RFID device serves the same purpose as a bar code or a magnetic strip in the back of a credit card or ATM card. Due to its capacity to deliver accurate and reliable data, it is used for wide variety of applications. With an aid of a suitable diagram, illustrate the operation of RFID. Then list TWO (2) application of RFID technology. C3 (20M)

CHAPTER 2:

CELLULAR COMMUNICATION SYSTEMS



Cellular communication systems are governed by various standards that define the technologies, protocols, and specifications used to enable seamless and efficient communication across large geographic areas as a wireless wide area network (WWAN), . The standards for cellular networks have evolved over the years with the advancement of technology.

Most WWANs are based on cellular technologies, such as GSM, UMTS, LTE, and 5G. These technologies enable the widespread deployment of wireless services and ensure seamless connectivity as users move across different coverage areas (cells) served by different base stations.

The core network is the backbone of the WWAN infrastructure, responsible for handling call routing, data transmission, and managing the connectivity of various base stations. It includes elements like Mobile Switching Centers (MSCs) and Gateway GPRS Support Nodes (GGSNs) in traditional cellular networks

The architecture of a cellular network is a complex and hierarchical structure that enables the efficient provision of mobile communication services to a large number of users within a wide geographic area. The architecture varies based on the generation of the cellular network (e.g., 2G, 3G, 4G, 5G), but the fundamental principles remain similar

The cellular network architecture is designed to handle a large number of simultaneous connections and to support various services, including voice calls, SMS, multimedia messaging, and data services. As technology evolves and new generations of cellular networks are introduced, the architecture adapts to meet the increasing demand for data, higher data rates, lower latency, and improved overall performance.

STRUCTURE QUESTION

SESSION: JUNE 2016

1. Generation of mobile phone standards such as 2nd Generation and 3rd Generation is set by the International Telecommunication Union (ITU). Differentiate the characteristics between these 2G and 3G technology. C2 (6M)

2. GSM system contains Network and Switching Subsystem (NSS) as one of the main elements in the architecture. Explain the Mobile Switching Centre (MSC) and Gateway MSC (GMSC) in NSS.C2 (3M)

3. To implement General Packet Radio System (GPRS), new nodes in GSM was developed. List the new nodes and draw the block diagram network for GPRS architecture. C3 (6M)

SESSION: DEC 2016

1. Summarize the differences of the cellular radio system form the first generation (1G) to the third generation (3G) in terms of frequency bands and applications in a suitable table. C2 (6M)

2. Identify THREE (3) functions of Radio Network Controller (RNC) in Universal Mobile Telecommunication System (UMTS). C2 (3M)

SESSION: JUNE 2017

1. Base Station Controller (BSC) is one of the main components in Base Station Subsystem (BSS). Explain the characteristics of a Base Station Controller (BSC). C3 (3M)

2. Network and Switching Subsystem (NSS) and Operation Subsystem (OSS) are two major subsystems in Global System for Mobile (GSM) system architecture. Illustrate both subsystems. C3 (6M)

SESSION: DEC 2017

1. Summarize the differences of the digital cellular radio system from the Second Generation (2G) to Fourth Generation (4G) in terms of its technology standard and channel bandwidth in a table. C2 (6M)

2. Identify THREE (3) main subsystems of Global System for Mobile communication (GSM) architecture. C2 (3M)

3. Illustrate the network architecture of the Universal Mobile Telecommunication System (UMTS) as a 3G wireless communication.C3 (6M)

4. Interpret the procedure of the Global System for Mobile communication (GSM) call set for an outgoing call from a mobile phone to the Public Switched Telephone Network (PSTN), with the aid of a diagram.C3 (6M)

SESSION: JUNE 2018

1. Distinguish the evolution of Wireless Wide Area Network (WWAN) from the Second Generation (2G) to the Fourth Generation (4G) in terms of the technology and type of services using a suitable table. C2 (6M)

2. Base Station Subsystem (BSS) and Network Switching Subsystem (NSS) are two major subsystems in GSM system architecture. Illustrate both subsystems. C3 (6M)

3. UMTS is one of the wireless communication system standard of the third generation (3G). Identify THREE (3) main elements in UMTS architecture. C2 (3M)

SESSION: DEC 2018

1. Referring to the evolution of Wireless Wide Area Network (WWAN) technology, explain THREE (3) differences between Third Generation (3G) and Fourth Generation (4G) in terms of technology standards, types of services and speed. C2 (6M)

2. Describe the types of GSM channel as an element connected between mobile to base station and base station to mobile. C2 (3M)

3. Long Term Evolution (LTE) is a standard for high-speed wireless communication for mobile phones and data terminals. Interpret the function of TWO (2) main elements in LTE network architecture. C3 (6M)

SESSION: JUNE 2018

1. Explain TWO (2) standard in 3G system. C3 (3M)

2. Construct the architecture that shows the main subsystem for LTE system. C3 (8M)

3. Sketch the data traffic call setup and routing sequence. C3 (8M)

SESSION I: 22/23

1. 3G is an advanced technology with improved features from 2G. Compare the 2G and 3G system in terms of its technology standard and types of service. C2 (5M)

SESSION II: 22/23

1. Explain the evolution (standards) of the cellular communication system in the 3G. (5M)

ESSAY QUESTION

SESSION II: 21/22

The GSM which is a standard for 2G) evolved to 2.5G with GPRS standard has created an avenue for the development of 3G and 4G standards such as UMTS and LTE cellular network. The era beyond 3G and 4G requires that cellular and radio technologies work together to form highly heterogeneous networks. By referring to Figure B1 below, group each architecture network component for each generation technology standard mentioned above in a suitable table. C4 (20M)

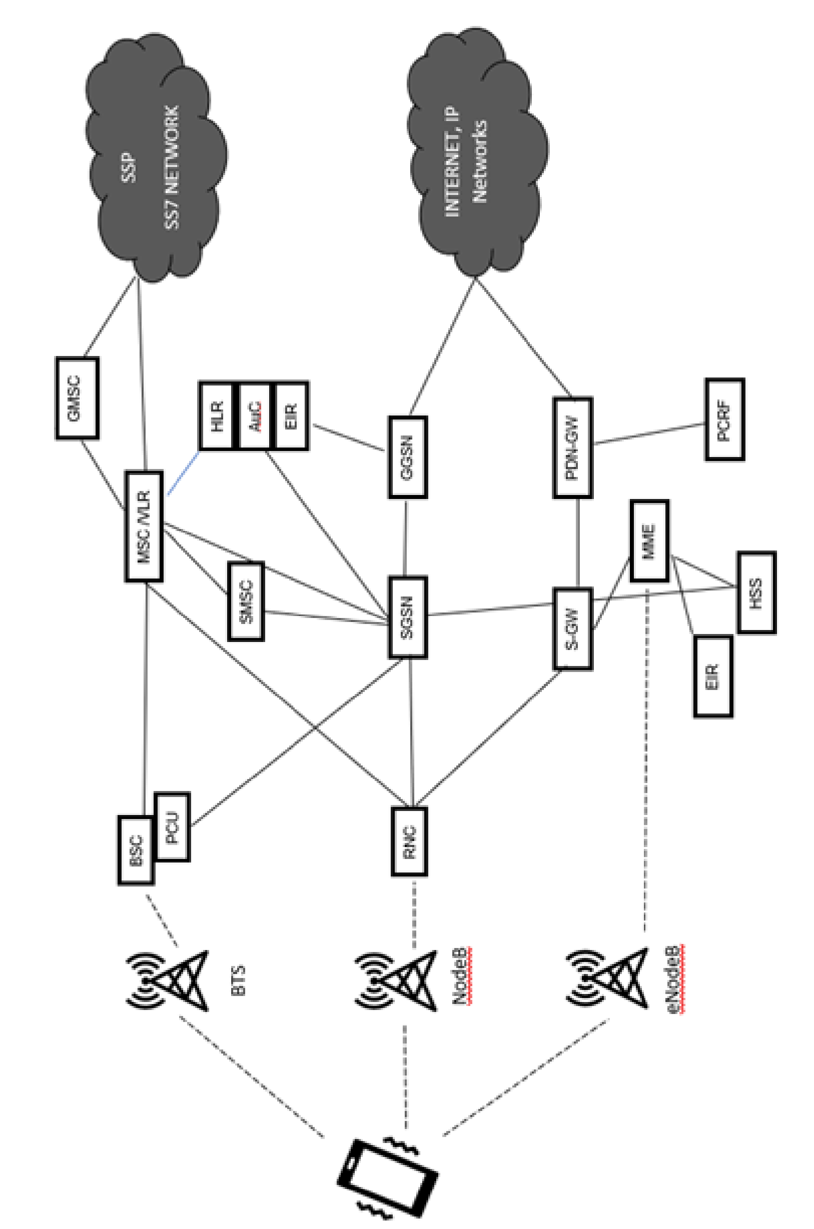


Figure B1: GSM to LTE Cellular Communication Network Architecture

SESSION I: 22/23

UMTS is a 3G network technology that inherited its core from 2G technology which is GSM / GPRS architecture to extend the capabilities of packet switched mobile network. Restructure the GSM architecture shown in Figure B2 by adding UMTS and GPRS components to show the capability of UMTS Terrestrial Radio Access Network (UTRAN) for handling Circuit Switched and Packet Switched data simultaneously. Then determine the function of each element added in the new architecture. C4 (20M)

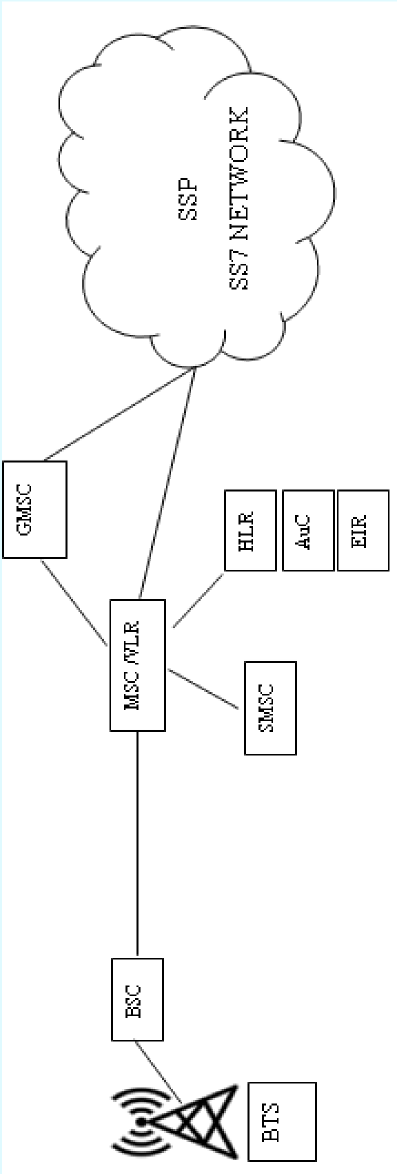


Figure B2 : GSM Cellular Communication Network Architecture

SESSION II: 22/23

GPRS is a packet-switching technology that enables data to be transferred through GSM networks. Components of GPRS are included as part of the whole GSM system to provide services such as mobile internet, Multimedia Messaging Services (MMS), and other data communications. By using a suitable diagram of network architecture, determine the function of each component of GPRS that is incorporated together with the GSM system. Your answer must include a diagram that clearly indicates the connection between GPRS and GSM. (20M)

CHAPTER 3:

CONCEPTS OF CELLULAR COMMUNICATION

Cellular communication systems are networks of interconnected base stations that allow mobile devices, such as cell phones, to communicate with each other and with the wider telecommunications infrastructure.

The basic concept in cellular communication is the division of a large geographic area into smaller, overlapping regions called cells. Each cell is served by a base station (cell tower) that communicates with mobile devices within its coverage area.

Coverage and capacity are two fundamental aspects of cellular communication that play a crucial role in providing reliable and efficient mobile communication services. Both factors are essential considerations in designing and optimizing cellular networks to meet the demands of users while ensuring seamless connectivity

Interference in cellular communication refers to the unwanted signals or noise that can disrupt the quality and reliability of wireless communication between mobile devices and the cellular network infrastructure. Interference can be caused by various factors, and it is a significant challenge for network operators as they strive to maintain optimal network performance and user experience.

Control channels and traffic channels serve distinct purposes in cellular communication. Control channels handle signaling and management tasks between mobile devices and the network, while traffic channels are responsible for carrying user data during voice calls, messaging, and data sessions. The proper allocation and management of these channels are essential to ensure efficient and reliable communication within the cellular network.

Efficient mobility management is a critical aspect of cellular communication that focuses on handling the movement of mobile devices (such as cell phones, smartphones, and tablets) as they traverse different cells within a cellular network

STRUCTURE QUESTION

SESSION: DEC 2016

1. Using a suitable diagram, illustrate Hard Handoff in cellular communication. C3 (6M)

SESSION: JUNE 2017

1. Describe the hand-over process between cells in cellular communication system using a suitable diagram. C3 (6M)

SESSION: JUNE 2018

1. Using a suitable diagram, illustrate Softer Hand-over in cellular communication. C3 (6M)

SESSION: DEC 2018

1. Illustrate Hard Handoff as one of handoff process in cellular communication system. C3 (6M)

SESSION II: 21/22

1. Capacity of cellular system become a major concern as demand for wireless service increases since congested traffic can degrade the quality of service. At this point, cellular design techniques are needed to provide more channels per unit coverage area. Carry out TWO (2) techniques for improving cell capacity in cellular system. C3 (10M)

2. Frequency reuses is a method to increase the coverage and capacity in cellular communication system. If the cellular network parameter is i = 1 and j = 3. Then calculate the cluster size, Co-Channel Reuse Ratio, and the radius of cell if the distance between the nearest co-channel cells for this cellular network is 78 km. C3 (10M)

3. Ali and Fatimah make a call when they are moving from base station A (bs A) to base station B (bs B). Ali uses 3G mobile system, his call run smoothly when he moves to bs B. But Fatimah uses 2G mobile system, facing a drop call when she moves to bs B. Assign the appropriate call transferring process with the aid of suitable diagram for both situations. C3 (10M)

SESSION I: 22/23

1. A cellular network distributes the link to and from end nodes wirelessly over land areas. Discuss the concept of cell and cluster using an illustration in cellular communication for the land area. C2 (4M)

2. Handover or handoff management enables the network to maintain a user's connection as the mobile station continues to move. Demonstrate how the process of hard and soft handover can be achieved. C3 (8M)

3. A new cellular system uses two 15kHz simplex to provide full duplex voice and control channel. The total band allocated for the system is 100MHz. If 3MHz of the spectrum is dedicated to control channels, calculate the distribution of voice and control channel for the system and the number of channels available per cell if the system uses 7-cell reuse. C3 (8M)

SESSION II: 22/23

1. Explain frequency reuse in cellular communication
(4M)

2. Figure A2 shows a cellular network system that uses the frequency reuse concept with plotting the boundary until 1st tier. The radius of the cell is 12 km. Calculate the size of the cluster (N), Co-Channel Reuse Ratio (Q), and the distance (D) between the nearest co-channel cells. (8M)

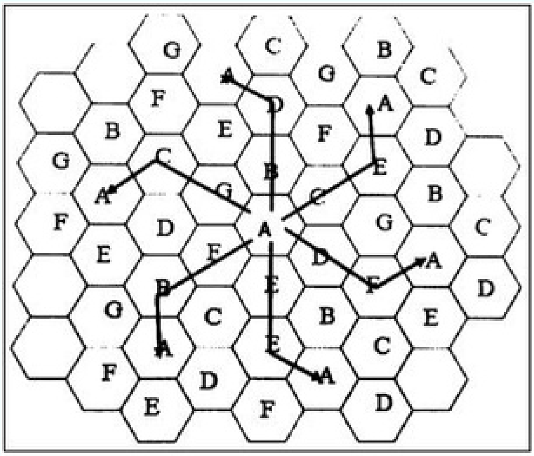


Figure A2

3. In a cellular network a total of 33 MHz of bandwidth is allocated to a particular FDD cellular telephone system which uses 20 kHz simplex channels to provide full duplex voice and control channels. Also, 2 MHz out of 33 MHz of the allocated spectrum is dedicated to controlling channels on the same system. Calculate the number of channels available per cell, equitable distribution of control channels and voice channels if the system uses 7 cells re-use. (8M)

ESSAY QUESTION

SESSION: JUNE 2017

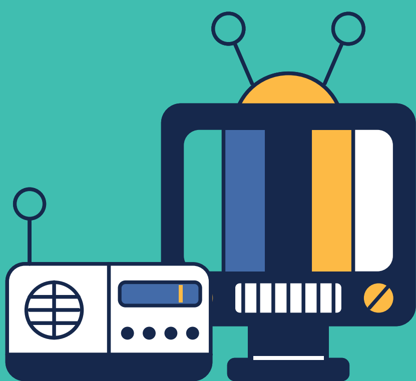
A cellular system uses two 30 kHz simplex channels to provide full duplex voice and control channel. The total band allocated for the system is 60 MHz. Calculate the number of channels available per cell if the system uses (a) 3-cell reuse (b) 4-cell reuse (c) 7-cell reuse (d) 12-cell reuse. If 3 MHz of the allocated spectrum is dedicated to the control channels, determine the distribution of voice and control channels in each cell in each of the four systems. C3 (20M)

SESSION: JUNE 2019

In mobile communication, hand-over is referred to the transformation of an ongoing call or data from one channel to another which are connected to the core network. It enables the users of cellular technology to receive their calls anywhere and at any time., so this process provides the mobility to the users, making it possible to the user to roam seamlessly from one cell to another cell. However, when the quality of links between base stations and mobile users are moving down from a certain threshold level, handover process should be implemented to preserve the quality of the services the user receives. In this process, existing links or deteriorating extensions will be delivered to cells that offer better link quality. Illustrate THREE (3) types of hand-over process in cellular communication network. C4 (20M)

CHAPTER 4:

RADIO WAVE PROPAGATION



Radio wave propagation refers to the way radio waves travel through the atmosphere or other mediums from a transmitter to a receiver. When radio waves encounter different materials or encounter the Earth's atmosphere, it can be affected in various ways, leading to different propagation characteristics.

Base stations use various types of antennas to transmit and receive signals. The choice of antenna depends on factors such as the frequency band of operation, coverage area, directionality requirements, and environmental constraints. Strategically deployed to achieve the desired coverage, capacity, and performance for the specific wireless network's requirements.

Multipath fading is a phenomenon that occurs in systems due to the presence of multiple signal paths between the transmitter and the receiver. When radio waves travel from a transmitter to a receiver, they can take multiple paths by reflecting off various surfaces, such as buildings, walls, or the ground, before reaching the receiver. These different paths can have different lengths, causing the signals to arrive at the receiver at slightly different times.

Small-scale fading is a type of fading that occurs due to the constructive and destructive interference of multipath signals in wireless communication systems. Unlike large-scale fading, which is mainly influenced by the distance between the transmitter and receiver, small-scale fading is a rapid and short-term fluctuation in the received signal strength caused by changes in the radio propagation environment over small distances or short time intervals.

The free space propagation model, also known as the free space path loss (FSPL) model, is a simple and fundamental model used to estimate the loss of signal strength as a radio wave propagates through free space without encountering any obstacles or reflections. It assumes a direct line-of-sight (LOS) path between the transmitter and receiver and does not take into account any fading effects, diffraction, or scattering.

STRUCTURE QUESTION

SESSION I: 22/23

Every antenna has a specialized application. One of the commonly used antenna is Directional antenna. Explain the FOUR (4) characteristics of Directional antenna as a base station antenna for signal coverage. C2 (4M)

SESSION II: 22/23

Compare TWO (2) types of base station antenna for coverage signal. (5M)

ESSAY QUESTION

SESSION: JUNE 2016

When the transmitting and receiving antennas are placed over a large distance and the received signal is in the Line of Sight path unobstructed, then the propagation model is the free space model. Consider a ground station antenna of gain 25dBi transmits signal at 52dBm. A satellite located at a distance of 41935km from the earth receives the signal. The gain of the receiver antenna satellite is 15dBi with frequency of transmission is 1GHz and assume there is no system loss. Using Friis Free space equation in log domain, calculate the received power in dBm at the satellite receiver. C3 (20M)

SESSION: DEC 2016

Assume a mobile communication system with 100W of effective radiated power is operating at 450 MHz and its transmitted from a Radio Base Station (RBS). Calculate the power that would be available at the mobile unit where the antenna has a gain of 2 dB, at a distance of 20 km, when the free space propagation loss (FSPL) condition existed . C3 (10M)

SESSION: DEC 2017

As an assistant RF engineer, you have been assigned to design a good cellular communication system by applying the Friss free space propagation and two-ray propagation model as a technical consideration, Given, a cellular communication transmitter has an output power of 165 W at a carrier frequency of 900MHz. It is connected to an antenna with a gain of 12dBi. The receiving antenna is 10 km away and has a gain of 6dBi. Calculate the power delivered to the receiver (in dBm), by considering the free space propagation. Assume that there are no other losses or mismatches in the system. Then, by using the two-ray propagation model, determine the propagation path loss if a radio signal is at 1800MHz, with a transmitting antenna height of 30 m and a receiving antenna height of 2 m, over the same distance as the above. Calculate the received power (in dBm) if the system using the receiving antenna with a gain of 5dBi and the transmitting antenna has a gain of 10dBi with transmitted power of 120W. C3 (20M)

SESSION: JUNE 2018

a) Assume a receiver is located 12km from a 60W transmitter. The carrier frequency is 900MHz, Gt = 1 and Gr = 2. Calculate the power at the receiver (in dBm), by considering the free space propagation. Assume that there is no loss in system hardware. C3 (8M)

b) Consider a wireless communication system with the following parameters:

- transmitted power: +20dBm
- minimum usable received power: -100dBm
- transmitting antenna gain: 10dB
- receiving antenna gain: 0dB
- carrier frequency: 1.1GHz

Calculate the range (the distance over which the wireless system will work) in free space. C3 (12M)

SESSION: DEC 2018

GSM1800 cellular radio system is designed with 30W transmission power from Base Transceiver Station (BTS 501). The BTS 501 is located 15 km away from mobile phone and the height of the antenna for BTS 501 and mobile phone are 200m and 3m respectively. The gain of BTS 501 and handphone antenna are 6dB and 2dB respectively. Assuming plane earth loss is between BTS 501 and mobile phone, calculate the power received signal (Watt and dBm) level at mobile phone by using Two Ray Model. Then, compute the power change if the mobile phone is moving at a distance of 30 km. C3 (20M)

SESSION II: 21/22

A cellular radio system is designed with 10W transmission power, 10dBi antenna gain and 100MHz frequency carrier from the Base Transceiver Station (BTS). Meanwhile, the power received signal level at mobile phone is -56dBm with 4dBi antenna gain. Calculate the distance between BTS and mobile phone by considering the free space propagation with no loss in system hardware. Then, compute the power received at the mobile antenna using Two Ray Model if the height of BTS and mobile phone are 30m and 1m respectively. Compare power received between the free space model and Two Ray model at mobile phone. C3 (20M)

SESSION I: 22/23

A mobile communication system transmitter has an output power 100W at a carrier frequency 100MHz connected to an antenna with antenna gain of 3 and 20m height. The receiving antenna is 15km away has antenna gain of 2 and 2m height. Calculate the power received at receiving antenna using Friss Free Space Model and Two -Ray Propagation Model by considering the free space propagation with no loss in system hardware. Then, assign which model has a good mobile communication system by considering path loss. C3 SESI (20M)

SESSION II: 22/23

A cellular radio system is designed with 40 W transmission power Base Transceiver Station (BTS 202). The BTS 202 is located 19 km away from the mobile phone and height of the antenna for BTS 202 and the mobile phone are 200 m and 2 m respectively. The gain of BTS 202 and mobile phone antenna are 5 dB and 3 dB respectively. Assuming the plane's earth loss between the BTS 202 and the mobile phone. Calculate the received power on the mobile phone at the located area, and the changes of received power if the mobile phone is travelling at a distance of 35 km, in Watt and dBm. C3 (20M)

A receiver is located 10 km from a transmitter. The carrier frequency is 1800 MHz and Gt = 1.64, Gr 1.64, Assume the speed of propagation for electro-magnetic waves = 3 x 108 m/s. Assume that the receives power is - 90 dBm. Calculate the path loss (in dB) under the free space propagation model. If the heights of the transmitting and receiving antennas are 50 m and 1.5 m, respectively, find the path loss (in dB) using the two-ray ground reflection model. Determine the received power (in mW) at d = 15 km for the above two models?

CHAPTER 5:

MULTIPLE ACCESS TECHNIQUE

Multiple Access Techniques (MAT) are methods used in wireless communication to allow multiple users or devices to share the same communication channel simultaneously. These techniques enable efficient utilization of the available bandwidth and resources, enabling multiple users to communicate without significant interference. Multiple access techniques are essential in various communication systems, including cellular networks, Wi-Fi networks, satellite communication, and more.

FDD and TDD are two duplexing techniques used in multiple access systems to separate the uplink and downlink transmissions in wireless communication. In FDMA, the available frequency spectrum is divided into multiple non-overlapping frequency bands or channels. Each user is allocated a unique frequency channel to transmit and receive data. FDMA is commonly used in analog communication systems. TDMA, the available time is divided into discrete time slots. Each user is assigned one or more time slots in a repetitive sequence. During their assigned time slot(s), users can transmit and receive data. TDMA is widely used in digital communication systems, such as GSM, where each user is allocated a specific time slot within a TDMA frame.

In CDMA, each user is assigned a unique spreading code that allows multiple users to share the same frequency and time simultaneously. The spreading codes differentiate between different users, and the receiver can recover the intended user's signal by using the appropriate code. CDMA is used in 3G (UMTS) and 4G (LTE) cellular networks.

OFDMA is a variation of FDMA used in modern wireless communication systems like Wi-Fi and 4G/5G cellular networks. It divides the available spectrum into multiple orthogonal subcarriers, allowing multiple users to share the same frequency band simultaneously. OFDMA provides increased flexibility and efficiency in resource allocation and enables dynamic allocation of subcarriers to different users based on their needs.

STRUCTURE QUESTION

SESSION: JUNE 2016

1. There are many types of multiple access technique in wireless communication such as Frequency Division Multiple Access (FDMA), Time Division Multiple Access (TDMA) and Code Division Multiple Access (CDMA). Identify THREE (3) objective of multiple access. C2 (3M)

SESSION: DEC 2016

1. Illustrate the spread spectrum techniques in Code Division Multiple Access (CDMA) with a suitable diagram. C3 (6M)

SESSION: JUNE 2017

1. Briefly describe THREE (3) main characteristics of FDMA. C2 (3M)

2. TDMA is a common multiple access technique used in digital 2G cellular systems. Illustrate the TDMA technique. C3 (6M)

3. Orthogonal Frequency Division Multiplexing Access (OFDMA) technique allows different users to transmit over different portions of the broadband spectrum. Illustrate the Orthogonal Frequency Division Multiplexing Access (OFDMA) technique. C3 (6M)

SESSION: DIS 2017

1. Briefly describe Time Division Multiple Access (TDMA). C2 (3M)

2. CDMA is a common multiple access techniques used in 3G cellular systems. Illustrate CDMA with a suitable diagram. C3 (6M)

3. Using a suitable diagram, illustrate OFDMA. C3 (6M)

SESSION: JUNE 2018

1. Briefly describe THREE (3) main characteristics of CDMA. C2 (3M)

2. FDMA is a common multiple access technique used in analog 1G cellular systems. Illustrate the FDMA techniques. C3 (6M)

SESSION: DIS 2018

1. Explain briefly THREE (3) objectives of multiple access techniques used in wireless communication. C2 (3M)

2. TDMA is one of the multiple access techniques used in wireless communication. Interpret the features of TDMA. C3 (6M)

3. Using a suitable diagram, interpret the OFDMA as one of the multiple access techniques in cellular communication system.C3 (6M)

SESSION: JUNE 2019

1. List TWO (2) objectives of multiple access techniques. C1 (4M)

2. Explain the characteristics of FDD and TDD in multiple access techniques. C2 (6M)

3. Using a suitable diagram, interpret the subsets of subcarriers to individual users in OFDMA.C3 (10M)

SESSION II: 21/22

1. TDMA is a channel access method for shared-medium networks technique used in digital 2G cellular system to maximize the available bandwidth. Show the FDD and TDD in TDMA. C3 (10M)

2. TDMA and CDMA are two major techniques used to share the available bandwidth in a wireless communication system. Carry out the concept and the generation used in both multiple access techniques using an appropriate diagram in a suitable table. C3 (10M)

SESSION I: 22/23

1. Discuss FOUR (4) reasons for using multiple access techniques while transmitting information in wireless communication for various subscribers. C2 (4M)

2. There are four main multiple access schemes that are used in cellular systems from the first analogue cellular technologies to current cellular technologies. With an aid of suitable diagrams, write about the FOUR (4) Multiple Access Techniques use in cellular communication as follows: FDMA, TDMA, CDMA and OFDMA. C3 (12M)

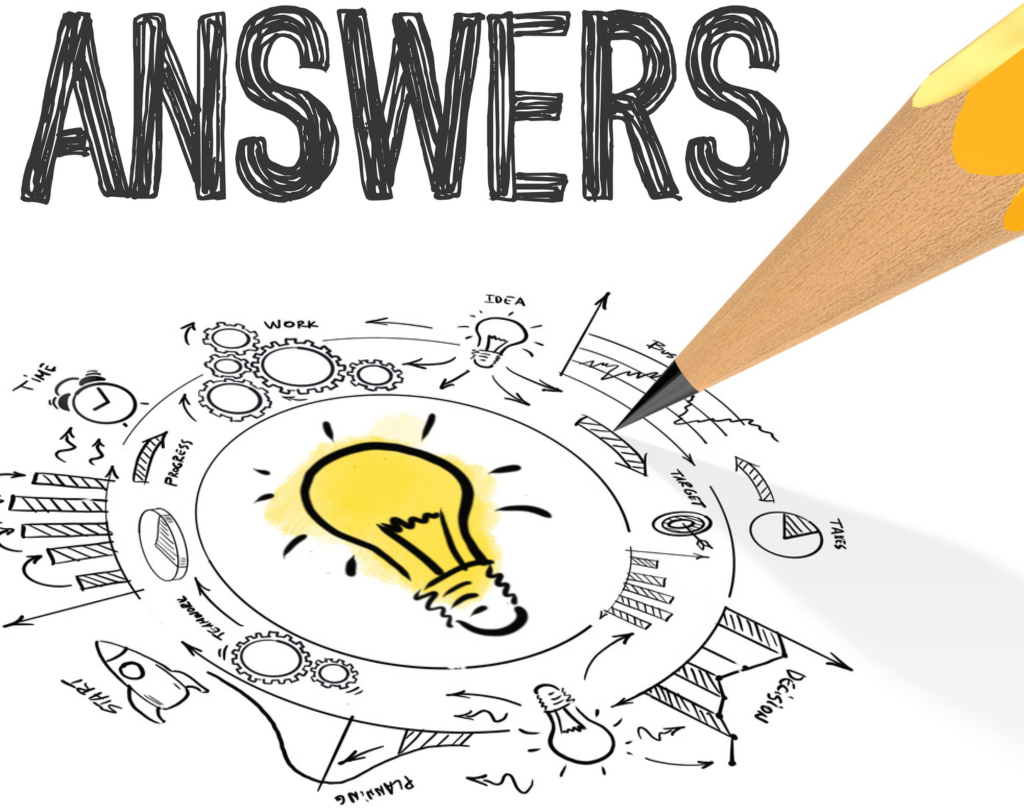
SESSION II: 22/23

1. Discuss the objectives of multiple access in cellular communication. (5M)

2. Show the subsets of subcarriers to individual users in OFDMA. (10M)

BELIEVE YOU CAN

ANSWERS



CHAPTER 3:CONCEPTS OF CELLULAR COMMUNICATION

SESSION: JUNE 2017

A cellular system uses two 30 kHz simplex channels to provide full duplex voice and control channel. The total band allocated for the system is 60 MHz. Calculate the number of channels available per cell if the system uses (a) 3-cell reuse (b) 4-cell reuse (c) 7-cell reuse (d) 12-cell reuse. If 3 MHz of the allocated spectrum is dedicated to the control channels, determine the distribution of voice and control channels in each cell in each of the four systems.

ANSWER:

Channel bandwidth = 30kHz x 2 = 40kHz
Total bandwidth = 60MHz
Control channel bandwitdh = 3MHz
Total available channels, S = 60MHz / 60kHz = 1000channels

for N = 3 cells
the total number of channels available per cell;
= S / N = 1000 / 3 = 333 channels

for N = 4 cells
the total number of channels available per cell;
= S / N = 1000 / 4 = 250 channels

for N = 7 cells

the total number of channels available per cell;

= S / N = 1000 /7 = 143 channels

for N = 12 cells

the total number of channels available per cell;

= S / N = 1000 /12 = 83 channels

Total channel available for control channel;

= 3MHz / 60kHz = 60 channels

for N = 3 cells; 50 / 3 = 17 control channel ;

among 333 channel, 316 for voice and 17 for control channel

for N = 4 cells; 50 / 4 = 13 control channel ;

among 250 channel, 237 for voice and 13 for control channel

for N = 7 cells; 50 / 7 = 7 control channel ;

among 143 channel, 136 for voice and 7 for control channel

for N = 12 cells; 50 / 12 = 4 control channel ;

among 83 channel, 79 for voice and 4 for control channel

SESSION II: 21/22

2. Frequency reuses is a method to increase the coverage and capacity in cellular communication system. If the cellular network parameter is i = 1 and j = 3. Then calculate the cluster size, Co-Channel Reuse Ratio, and the radius of cell if the distance between the nearest co-channel cells for this cellular network is 78 km.

ANSWER:

$i = 1$

$j = 3$

$d = 78km$

$N = i^2 + j^2 + (i)(j)$

$= 1^2 + 3^2 + (1)(3)$

$= 13$

$Q = \sqrt{3N}$

$Q = \sqrt{3(13)}$

$= 6.24$

$Q = D / R$

$6.24 = 78 / R$

$R = 12.5km$

SESSION I: 22/23

3. A new cellular system uses two 15kHz simplex to provide full duplex voice and control channel. The total band allocated for the system is 100MHz. If 3MHz of the spectrum is dedicated to control channels, calculate the distribution of voice and control channel for the system and the number of channels available per cell if the system uses 7-cell reuse.

ANSWER:

Channel bandwidth = 15kHz x 2 = 30kHz

Total bandwidth = 100MHz

Total control channel bandwidth = 3MHz

Total available channels = 100MHz / 30kHz = 3333 channels

for 7 cells

the total number of channels available per cell;

= 3333 / 7 = 476 channels

Total bandwidth for voice channel:

Total bandwidth - control channel bandwidth;

= 100MHz - 3Mhz = 97MHz

Total channel available for control channel;

= 3MHz / 30kHz = 100 channels

Control channel per cell = 50 / 7 = 14 channels

Total channel available for voice channel;

= 97MHz / 40kHz = 3233 @ *3333 -100 = 3233* channels

Voice channel per cell = 3233 / 7 = 462

@ 476 -14 = 462 channels

SESSION II: 22/23

2. Figure A2 shows a cellular network system that uses the frequency reuse concept with plotting the boundary until 1st tier. The radius of the cell is 12 km. Calculate the size of the cluster (N), Co-Channel Reuse Ratio (Q), and the distance (D) between the nearest co-channel cells.

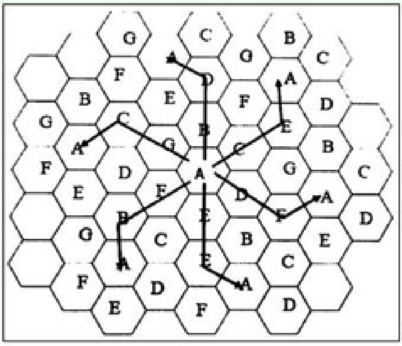


Figure A2

ANSWER:

i = 2

j = 1

R= 12km

N = i^2 + j^2 + (i)(j)

= 2^2 + 1^2 + (1)(2)

= 7

Q = √(3N)

Q = √(3(7))

= 4.58

Q = D / R

4.58 = D / 12

D = 54.96km

3. In a cellular network a total of 33 MHz of bandwidth is allocated to a particular FDD cellular telephone system which uses 20 kHz simplex channels to provide full duplex voice and control channels. Also, 2 MHz out of 33 MHz of the allocated spectrum is dedicated to controlling channels on the same system. Calculate the number of channels available per cell, equitable distribution of control channels and voice channels if the system uses 7 cells re-use.

ANSWER:

Channel bandwidth = 20kHz x 2 = 40kHz

Total bandwidth = 33MHz

Total available channels = 33MHz / 40kHz = 750 channels

for 7 cells

the total number of channels available per cell;

= 750 / 7 = 107 channels

Total bandwidth for voice channel:

Total bandwidth - control channel bandwidth;

= 33MHz - 2Mhz = 31MHz

Total channel available for control channel;

= 2MHz / 40kHz = 50 channels

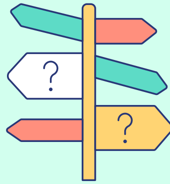
Control channel per cell = 50 / 7 = 7 channels

Total channel available for voice channel;

= 31MHz / 40kHz = 775 channels

Voice channel per cell = 775 / 7 = 111 channels

CHAPTER 4:RADIO WAVE PROPAGATION



SESSION: JUNE 2016

When the transmitting and receiving antennas are placed over a large distance and the received signal is in the Line of Sight path unobstructed, then the propagation model is the free space model. Consider a ground station antenna of gain 25dBi transmits signal at 52dBm. A satellite located at a distance of 41935km from the earth receives the signal. The gain of the receiver antenna satellite is 15dBi with frequency of transmission is 1GHz and assume there is no system loss. Using Friis Free space equation in log domain, calculate the received power in dBm at the satellite receiver.

ANSWER:

Pt = 52dBm

Gt = 25dBi

Gr = 15dBi

d = 41935 km

f = 1GHz

Pr = Pt + Gt + Gr – PL

PL = 20 log (d) + 20 log (f) + 32.44

PL = 20 log (41935) + 20 log (1000) + 32.44 = 184.89dB

Pr = 52dBm + 25dBi + 15dBi – 184.89dB = -92.89dBm converting Pr into log domain

$$Pr = 10 \log (Pw / 1m)$$

$$-92.89dBm = 10 \log (Pw / 1m)$$

$$-92.89 / 10 = \log (Pw / 1m)$$

$$-9.289 = \log (Pw / 1m)$$

$$\text{shift} \log (-9.289) = Pw / 1m$$

$$5.14 \times 10^{(-10)} = Pw / 1m$$

$$(5.14 \times 10^{(-10)}) \times 1m = Pw$$

$$Pr \text{ in Watt} = 5.14 \times 10^{(-13)} W$$

SESSION: DEC 2016

Assume a mobile communication system with 100W of effective radiated power is operating at 450 MHz and its transmitted from a Radio Base Station (RBS). Calculate the power that would be available at the mobile unit where the antenna has a gain of 2 dB, at a distance of 20 km, when the free space propagation loss (FSPL) condition existed .

ANSWER:

Pt = 100W

= 10 log (Pt/ 1m)

= 10 log (100 / 0.001) = 50dBm

f = 450Mhz

Gt = 2dB

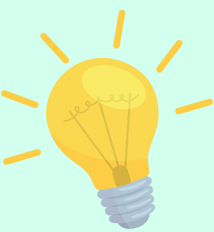
d = 20 km

PL = 20 log (d) + 20 log (f) + 32.44

PL = 20 log (20) + 20 log (450) + 32.44 = 111.52dB

Pr = Pt + Gt + Gr – PL

Pr = 50dBm + 2dBi + 0dBi – 111.52dB = -59.52dBm



SESSION: DEC 2017

As an assistant RF engineer, you have been assigned to design a good cellular communication system by applying the Friss free space propagation and two-ray propagation model as a technical consideration, Given, a cellular communication transmitter has an output power of 165 W at a carrier frequency of 900MHz. It is connected to an antenna with a gain of 12dBi. The receiving antenna is 10 km away and has a gain of 6dBi. Calculate the power delivered to the receiver (in dBm), by considering the free space propagation. Assume that there are no other losses or mismatches in the system. Then, by using the two-ray propagation model, determine the propagation path loss if a radio signal is at 1800MHz, with a transmitting antenna height of 30 m and a receiving antenna height of 2 m, over the same distance as the above. Calculate the received power (in dBm) if the system using the receiving antenna with a gain of 5dBi and the transmitting antenna has a gain of 10dBi with transmitted power of 120W.

ANSWER:

Pt = 165W

= 10 log (Pt/ 1m)

= 10 log (165 / 0.001) = 52.17dBm

f = 900Mhz

Gt = 12dBi

Gr = 6dBi

d = 10 km

PL = 20 log (d) + 20 log (f) + 32.44

PL = 20 log (10) + 20 log (900) + 32.44 = 111.52dB

Pr = Pt + Gt + Gr – PL

Pr = 52.17dBm + 12dBi + 6dBi – 111.52dB =

-41.35dBm

using Two Ray propagation model

Pt = 120W

= 10 log (Pt/ 1m)

= 10 log (120 / 0.001) = 50.79dBm

f = 1800Mhz

ht = 30m ~ 0.03km

hr = 2m ~ 0.002km

Gt = 10dBi

Gr = 5dBi

d = 10 km

PL = 40 log (d) - 20 log (ht) - 20 log (hr)

PL = 40 log (10) + 20 log (0.03) + 20 log (0.002) = 124.437dB

Pr = Pt + Gt + Gr – PL

Pr = 50.79dBm + 10dBi + 5dBi – 124.437dB = -58.645dBm

SESSION: JUNE 2018

a) Assume a receiver is located 12km from a 60W transmitter. The carrier frequency is 900MHz, Gt = 1 and Gr = 2. Calculate the power at the receiver (in dBm), by considering the free space propagation. Assume that there is no loss in system hardware.

b) Consider a wireless communication system with the following parameters:

- *transmitted power: +20dBm*
- *minimum usable received power: -100dBm*
- *transmitting antenna gain: 10dB*
- *receiving antenna gain: 0dB*
- *carrier frequency: 1.1GHz*

Calculate the range (the distance over which the wireless system will work) in free space.

ANSWER: a)

Pt = 60W

= 10 log (Pt/ 1m)

= 10 log (60 / 0.001) = 47.78dBm

f = 900Mhz

Gt = 1 ; 10 log 1 = 0dBi

Gr = 2 ; 10 log 2 = 3dBi

d = 12km

PL = 20 log (d) + 20 log (f) + 32.44

PL = 20 log (12) + 20 log (900) + 32.44 = 113.01dB

Pr = Pt + Gt + Gr – PL

Pr = 47.78dBm + 0dBi + 3dBi – 113.01dB = -62.33dBm

ANSWER: b)

$Pt = 20dBm$

$Pr = -100dBm$

$Gt = 10dB$

$Gr = 0dB$

$f = 1.1GHz \sim 1100MHz$

$Pr = Pt + Gt + Gr - PL$

$-100 = 20dBm + 10Bi + 0dBi - PL$

$PL = 130dB$

$PL = 20 \log (d) + 20 \log (f) + 32.44$

$130 = 20 \log (d) + 20 \log (1100) + 32.44$

$130 = 20 \log (d) + 93.27$

$\log (d) = (130 - 93.26) / 20$

$\log (d) = 1.836$

$d = 68.64km$

SESSION: DEC 2018

GSM1800 cellular radio system is designed with 30W transmission power from Base Transceiver Station (BTS 501). The BTS 501 is located 15 km away from mobile phone and the height of the antenna for BTS 501 and mobile phone are 200m and 3m respectively. The gain of BTS 501 and handphone antenna are 6dB and 2dB respectively. Assuming plane earth loss is between BTS 501 and mobile phone, calculate the power received signal (Watt and dBm) level at mobile phone by using Two Ray Model. Then, compute the power change if the mobile phone is moving at a distance of 30 km.

ANSWER:

Pt = 30W

= 10 log (Pt/ 1m)

= 10 log (30 / 0.001) = 44.77dBm

ht = 200m; 0.2km

hr = 3m; 0.003km

Gt = 6dBi

Gr = 2dBi

d = 15 km

PL = 40 log (d) - 20 log (ht) - 20 log (hr)

PL = 40 log (15) - 20 log (0.2) - 20 log (0.003) = 111.48dB

Pr = Pt + Gt + Gr – PL

Pr = 44.77dBm + 6dBi + 2dBi – 111.48dB = -58.71dBm

-58.71dBm in Watt

-58.71 = 10 log (Pw / 1m)

-58.71 / 10 = log (Pw/ 1m)

-5.871 = log (Pw/ 1m)

shift log (-5.871) = Pw / 1m

1.3456 x 10^(-6) = Pw / 1m

(1.3456 x 10^(-6)) x 1m = Pw

Pr in Watt = 1.3456 x 10^(-9) W @ 1.35nW

if mobile moving to d = 30 km

PL = 40 log (d) - 20 log (ht) - 20 log (hr)

PL = 40 log (30) - 20 log (0.2) - 20 log (0.003) = 123.52dB

Pr = Pt + Gt + Gr – PL

Pr = 44.77dBm + 6dBi + 2dBi – 123.52dB = -70.75dBm

SESSION II: 21/22

A cellular radio system is designed with 10W transmission power, 10dBi antenna gain and 100MHz frequency carrier from the Base Transceiver Station (BTS). Meanwhile, the power received signal level at mobile phone is -56dBm with 4dBi antenna gain. Calculate the distance between BTS and mobile phone by considering the free space propagation with no loss in system hardware. Then, compute the power received at the mobile antenna using Two Ray Model if the height of BTS and mobile phone are 30m and 1m respectively. Compare power received between the free space model and Two Ray model at mobile phone.

ANSWER:

Pt = 10W

=10 log 〖10/1m〗 =40dBm

Gt = 10dBi

f =100MHz

Gr = 4dBi

Pr = -56dBm

Free Space

Pr = Pt + Gt + Gr – PL

-56 = 40 + 10 + 4 – PL

- 56 = 54 – PL

PL = 110 dBm

PL = 20 log 20 (d) + 20 log (f) + 32.44

110 = 20 log (d) + 20 log (100) + 32.44

110 = 20 log (d) + 72.44

37.56 = 20 log (d)

Log d = 1.88

d = 75.85km

Two Ray Model

ht = 30m

hr = 1m

PL = 40 log (d) - 20 log (ht) – 20 log (hr)

PL = 40 log (75.85) - 20 log (0.03) – 20 log (0.001)

PL = 165.65dB

Pr = Pt + Gt + Gr – PL

= 40 + 9 +4 – 165.65

= -112.65dBm

~power received at mobile phone antenna using Two Ray model (-88.62dBm) is smaller than free space (-56dBm) because Two Ray model considered reflection signal to the ground

SESSION I: 22/23

A mobile communication system transmitter has an output power 100W at a carrier frequency 100MHz connected to an antenna with antenna gain of 3 and 20m height. The receiving antenna is 15km away has antenna gain of 2 and 2m height. Calculate the power received at receiving antenna using Friss Free Space Model and Two - Ray Propagation Model by considering the free space propagation with no loss in system hardware. Then, assign which model has a good mobile communication system by considering path loss.

ANSWER:

Pt = 100W

=10 log 〖100/1m〗 =50dBm

Gt = 3; 10 log 3 = 4.77dBi

Gr = 2; 10 log 2 = 3dBi

f = 100MHz

d = 15km

ht = 20m = 0.02km

hr = 2m = 0.0002km

Friis Free Space

PL = 20 log d + 20 log f + 32.44

= 20 log 15 + 20 log 100 + 32.44

= 95.96 dB

Pr = Pt + Gt + Gr - PL

= 50 + 4.77 + 3 – 95.96

= -38.19 dBm

Two Ray Model

PL = 40 log (d) - 20 log (ht) – 20 log (hr)

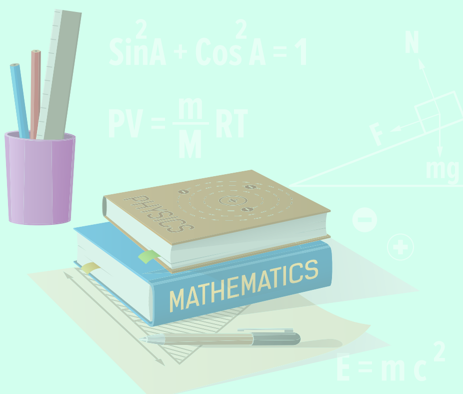
PL = 40 log (15) - 20 log (0.02) – 20 log (0.0002)

PL = 135dB

Pr = Pt + Gt + Gr – PL

= 50 + 4.77 +3 – 135

= -77.23dBm



SESSION II: 22/23

A cellular radio system is designed with 40 W transmission power Base Transceiver Station (BTS 202). The BTS 202 is located 19 km away from the mobile phone and height of the antenna for BTS 202 and the mobile phone are 200 m and 2 m respectively. The gain of BTS 202 and mobile phone antenna are 5 dB and 3 dB respectively. Assuming the plane's earth loss between the BTS 202 and the mobile phone. Calculate the received power on the mobile phone at the located area, and the changes of received power if the mobile phone is travelling at a distance of 35 km, in Watt and dBm.

ANSWER:

Pt = 40W

=10 log 〖40/1m〗 =46.02dBm

Gt = 5dBi

Gr = 3dBi

d = 19km

ht = 200m = 0.2km

hr = 2m = 0.002km

PL = 40 log (d) - 20 log (ht) – 20 log (hr)

PL = 40 log (19) - 20 log (0.2) – 20 log (0.002)

PL = 119dB

Pr = Pt + Gt + Gr – PL

= 46.02 + 5 +3 – 119

= -65.08dBm

-65.08dBm in Watt

-65.08 = 10 log (Pw / 1m)

-65.08 / 10 = log (Pw/ 1m)

-6.508 = log (Pw/ 1m)

shift log (-6.508) = Pw / 1m

3.098 x 10^(-7) = Pw / 1m

(3.098 x 10^(-7)) x 1m = Pw

Pr in Watt = 3.098 x 10^(-10) W @ 0.31nW

d = 35 km

PL = 40 log (d) - 20 log (ht) – 20 log (hr)

PL = 40 log (35) - 20 log (0.2) – 20 log (0.002)

PL = 129.72dB

Pr = Pt + Gt + Gr – PL

= 46.02 + 5 +3 – 129.72

= -75.70dBm

-75.70dBm in Watt

-75.70 = 10 log (Pw / 1m)

-75.70 / 10 = log (Pw/ 1m)

-7.570 = log (Pw/ 1m)

shift log (-7.570) = Pw / 1m

2.69 x 10^(-8) = Pw / 1m

(2.69 x 10^(-8)) x 1m = Pw

Pr in Watt = 2.69 x 10^(-11) W @ 0.0269nW

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