FIRST TERM EXAMINATION [SEPT. 2017]
SEVENTH SEMESTER [B.TECH.]
WIRELESS COMMUNICATION
[ETEC–405]

Time : 1.30 hrs. **M.M. : 30**

Note: *Attempt any three question in all and Q.1 is compulsory.*

Q.1. Attempts all parts of the following:

Q.1. (a) What is the radio propagation mechanism? (3)

Ans. Radio propagation depends on the frequency being used & the type of atmospheric conditions prevailing. This can be divided among the following categories:

1. Free Space Propagation: Here the radio signal travels through the open space. The distance coming in between the transmitter and receiver acts as the major loss for the strength of radio signal satellite communication is a major application for this type of communication.

2. Ground Wave Propagation: This mechanism of propagation occurs for the frequencies below 2MHz. During the propagation, the signal follows the curvature of earth.

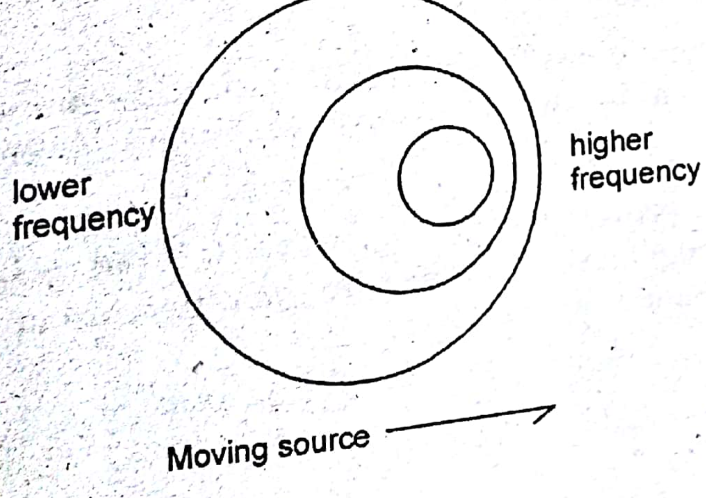
3. Ionospheric Propagation: This is also known as sky wave propagation. This is used for a range of 2 to 30 MHz. here the radio signal is reflected from the ionosphere towards the earth surface.

4. Troposphere Propagation: Here the signal travels through the troposphere where there is a significant change in refractive index of the air medium.

Q.1. (b) What is Doppler effect? Explain. (3)

Ans. The Doppler effect can be described as the effect produced by a moving source of waves in which there is an apparent upward shift in frequcncy for observers towards whom the source is approaching and an apparent downward shift in frequency for observers from whom the source is receding. For example if a pure sinusoidal tone of frequency is transmitted and it is denoted as Fc, then the received signal spectrum is known as Doppler spectrum consisting of components in the range from Fc-Fd to Fc + Fd, in which Fd refers to Doppler shift frequency.

The total amount of the spectral broadening will depend on the Doppler shift Fd.



Q.1. (c) What do you mean by mobility management? How is it done? (4)

Ans. Mobility Management: A Mobile station is assigned a home network, commonly known as location area. When an MS migrates out of its current BS into the footprint of another, a procedure is performed to maintain service continuity, known as Handoff management. An agent in the home network, called home agent, keeps track of the current location of the MS. The procedure to keep track of the user's current location is referred to as Location management.

Handoff management and location management together are referred to as Mobility Management.

Handoff: At any instant, each mobile station is logically in a cell and under the control of the cell's base station. When a mobile station moves out of a cell, the base station notices the MS's signal fading away and requests all the neighboring BSs to report the strength they are receiving. The BS then transfers ownership to the cell getting the strongest signal and the MSC changes the channel carrying the call. The process is called handoff. There are two types of handoff; Hard Handoff and Soft Handoff. In a hard handoff, which was used in the early systems, a MS communicates with one BS. As a MS moves from cell A to cell B, the communication between the MS and base station of cell A is first broken before communication is started between the MS and the base station of B. As a consequence, the transition is not smooth. For smooth transition from one cell (say A) to another (say B), an MS continues to talk to both A and B. As the MS moves from cell A to cell B, at some point the communication is broken with the old base station of cell A. This is known as soft handoff.

Roaming: Two fundamental operations are associated with Location Management; location update and paging. When a Mobile Station (MS) enters a new Location Area, it performs a location updating procedure by making an association between the foreign agent and the home agent. One of the BSs, in the newly visited Location Area is informed and the home directory of the MS is updated with its current location. When the home agent receives a message destined for the MS, it forwards the message to the MS via the foreign agent. An authentication process is performed before forwarding the message.

Q. 2. (a) Describe free space propagation model for mobile radio wave propogation. (6)

Ans. Free space model predicts that the received power decays as negative square root of the distance. Friis free space equation is given by

$$Pr(d) = (PtGt\,Gr\,\lambda^{2})/(4\pi)^2 d^2 L$$

Where Pt is the transmitted power, Pr(d) is the received power, Gt is the transmitter antenna gain, Gr is the receiver antenna gain, d is the Tx-Rx separation and L is the system loss factor depended upon line attenuation, filter losses and antenna lossesand not related to propagation.

The gain of the antenna is related to the effectiveaperture of the antenna which in turn is dependent upon the physical size of theantenna as given below

$$G = 4\pi Ae/\lambda^2$$

The path loss, representing the attenuation suffered by the signal as it travels through the wireless channel is given by the difference of the transmitted and receivedpower in dB and is expressed as:

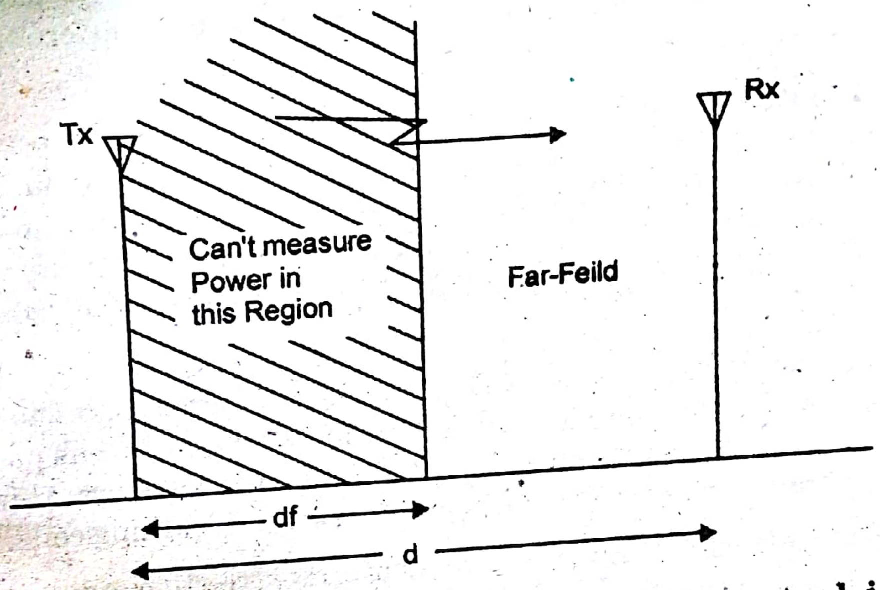
$$PL(dB) = 10\log Pt/Pr$$

The fields of an antenna can broadly be classified in two regions, the far field andthe near field. It is in the far field that the propagating waves act as plane wavesand the power decays inversely with distance. The far field region is also termed as Fraunhofer region and the Friis equation holds in this region. Hence, the Friis equation is used only beyond the far field distance, df, which is dependent upon thelargest dimension of the antenna as.

$$df = 2D^2/\lambda$$

Also we can see that the Friis equation is not defined for d=0. For this reason, weuse close in distance, do, as a reference point. The power received, Pr(d), is then given by:

$$Pr(d) = Pr(do)(do/d)^2$$



Q.2. (b) What do you understand by power control in wireless communication?

Ans. Power control can substantially impact the capacity and perceived quality in cellular wireless systems. Regardless of the mode of multiple access — be it frequency, time or code division — power control is necessary to combat the intercell, or co-channel, interference that arises from frequency reuse.

Additionally, power control is employed to minimize the intra-cell interference in direct sequence code division multiple access (DS-CDMA) systems. On an ideal channel, it is possible to maintain code orthogonality among all users of the same cell. A wireless channel introduces multipath, so this perfect code orthogonality is destroyed and the user experiences intracell interference. Power control is particularly crucial on the DS-CDMA uplink: without it, the signal of a mobile at the cell periphery would be drowned out by an interfering mobile situated close to the base station. Furthermore, on the DS-CDMA uplink the code waveforms of different users arrive at the receiver unsynchronized with one another. Unless the receiver performs code resynchronization, the interference is heightened, exacerbating this "near-far" problem and increasing the need for power control.

Intracell interference can affect TDMA and FDMA systems as well, in the form of adjacent channel interference; for example, practical band pass filters cannot perfectly reject adjacent frequencies, matched filters may not always sample over the correct intervals, and multipath can cause intersymbol interference across different users. This need for power control in cellular systems to combat interference has been recognized and is the subject of much research.

Q.3. (a) What are the various mechanism for capacity increase. Explain in detail. **(5)**

Ans. Methods for Capacity Increases

• **Quiet periods during speech transmission:** for speech transmission, CDMA makes implicit useof the fact that a person does not talk continuously, but rather only about 50% of the time, theremainder of the time (s) he listens to the other participant. In addition, there are pauses betweenwords and even syllables, so that the ratio of "talk time" to "total time of a call" is about 0.4.During quiet periods, no signal, or a signal with a very low data rate, has to be transmitted. In a CDMA system, not transmitting information leads to a decrease in total transmitted power, andthus interference in the system. But we have already seen above that decreasing the interferencepower allows additional users to place calls.

• **Flexible data rate:** in an FDMA (TDMA) system, a user can occupy either one frequency (timeslot), or integer multiples thereof. In a CDMA system, arbitrary data rates can be transmitted. Actually, most systems transmit comfort noise during this time i.e., some background noise. People speakinginto a telephone feel uncomfortable (think the connection has been interrupted) if they cannot hear any soundwhile they talk.

• **Soft capacity:** the capacity of a CDMA system can vary from cell to cell. If a given cell addsmore users, it increases interference to other cells. It is thus possible to have some cells withhigh capacity, and some with lower; furthermore, this can change dynamically, as traffic changes.This concept is known as breathing cells.

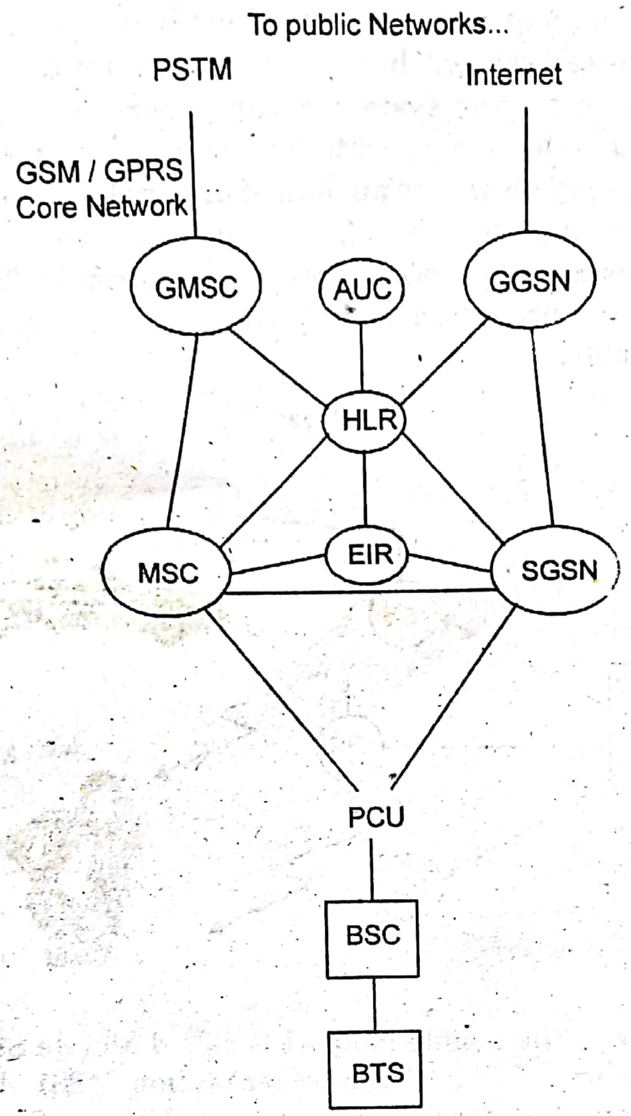
• **Error correction coding:** the drawback of error correction coding is that the data rate that is tobe transmitted is increased, which decreases spectral efficiency. On the other hand, CDMA consciouslyincreases the amount of data to be transmitted. It is thus possible to include errorcorrection coding without decreasing spectral efficiency; in other words, different users aredistinguished by different error correction codes (coding by spreading).

Q.3. (b) Explain the GPRS architecture. **(5)**

Ans. The GPRS is an enhancement over the GSM and adds some nodes in the network to provide the packet switched services. These network nodes are called GSNs (GPRS Support Nodes) and are responsible for the routing and delivery of the data packets to and from the MS and external packet data networks (PDN). The most important network nodes added to the existing GSM networks are:

- SGSN (Serving GPRS Support Node).
- GGSN (Gateway GPRS Support Node).

The serving GPRS support node (SGSN) is responsible for routing the packet switched data to and from the mobile stations (MS) within its area of responsibility. The main functions of SGSN are packet routing and transfer, mobile attach and detach procedure (Mobility Management (MM)), location management, assigning channels and time slots (Logical Link Management (LLM)), authentication and charging for calls. It stores the location information of the user (like the current location, current VLR) and user profile (like IMSI addresses used in packet data networks) of registered users in its location register.



The gateway GPRS support node (GGSN) acts as interface between the GPRS backbone and the external packet data network (PDN). It converts the GPRS packet coming from the SGSN into proper packet data protocol (PDP) format (i.e. X.25 or IP) before sending to the outside data network. Similarly it converts the external PDP addresses to the GSM address of the destination user. It sends these packets to proper SGSN. For this purpose the GGSN stores the current SGSN address of the user and his profile in its location register. The GGSN also performs the authentication and charging functions. In general there may be a many to many relationship between the SGSN and GGSN. However a service provider may have only one GGSN and few SGSNs due to cost constraints. A GGSN proved the interface to several SGSNs to the external PDN.

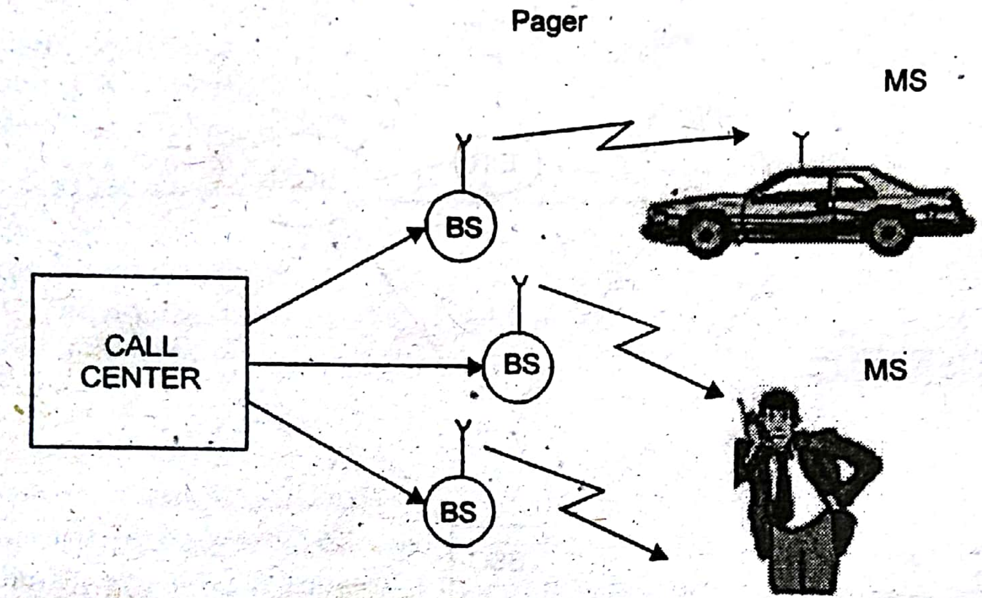
Q. 4. Write a short note on-

(a) Paging systems **(3)**

Ans. Paging systems are unidirectional wireless communications systems. They arecharacterized by the following properties:

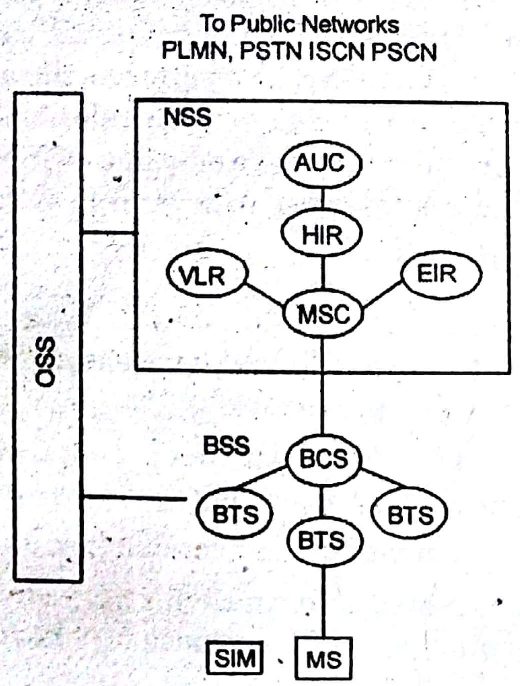
- The user can only receive information, but cannot transmit. Consequently, a "call" (message) can only be initiated by the call center, not by the user.
- The information is intended for, and received by, only a single user.
- The amount of transmitted information is very small. Originally, the received information consistedof a single bit of information, which indicated to the user that

"somebody has sent you amessage." The user then had to make a phone call (usually from a payphone) to the call center,where a human operator repeated the content of the waiting message. Later, paging systemsbecame more sophisticated, allowing the transmission of short messages (e.g., a different phonenumber that should be called, or the nature of an emergency). Still, the amount of informationwas rather limited. Due to the unidirectional nature of the communications, and the small amount of information,the bandwidth required for this service is small. This in turn allows the service to operate at lowercarrier frequencies – e.g., 150MHz – where only small amounts of spectrum are available.



Q.4. (b) GSM **(4)**

Ans. In GSM system the mobile handset is called Mobile Station (MS). A cell is formed by the coverage area of a Base Transceiver Station (BTS) which serves the MS in its coverage area. Several BTS together are controlled by one Base Station Controller (BSC). The BTS and BSC together form Base Station Subsystem (BSS). The combined traffic of the mobile stations in their respective cells is routed through a switch called Mobile Switching Center (MSC). Connection originating or terminating from external telephone (PSTN) are handled by a dedicated gateway Gateway Mobile Switching Center (GMSC)



In addition to the above entities several databases are used for the purpose of call control and network management. These databases are Home Location Register (HLR), Visitor Location Register (VLR), the Authentication Center (AUC), and Equipment Identity Register (EIR).

Home Location Register (HLR) stores the permanent (such as user profile) as well as temporary (such as current location) information about all the users registered with the network. A VLR stores the data about the users who are being serviced currently. It includes the data stored in HLR for faster access as well as the temporary data like location of the user. The AUC stores the authentication information of the user such as the keys for encryption. The EIR stores stores data about the equipments and can be used to prevent calls from a stolen equipments.

All the mobile equipments in GSM system are assigned unique id called IMSI (International Mobile Equipment Identity) and is allocated by equipment manufacturer and registered by the service provider. This number is stored in the EIR. The users are identified by the IMSI (International Module Subscriber Identity) which is stored in the Subscriber Identity Module (SIM) of the user. A mobile station can be used only if a valid SIM is inserted into equipment with valid IMSI. The "real" telephone number is different from the above ids and is stored in SIM.

Q.4. (c) IS-95 CDMA **(3)**

Ans. Interim Standard 95 (IS-95) was the first ever CDMA-based digital cellular technology. It was developed by Qualcomm and later adopted as a standard by the Telecommunications Industry Association in TIA/EIA/IS-95 release published in 1995. The proprietary name for IS-95 is cdma One.

It is a 2G mobile telecommunications standard that uses CDMA, a multiple access scheme for digital radio, to send voice, data and signaling data (such as a dialed telephone number) between mobile telephones and cell sites.

CDMA or "code division multiple access" is a digital radio system that transmits streams of bits (PN codes). CDMA permits several radios to share the same frequencies. Unlike TDMA "time division multiple access", a competing system used in 2G GSM, all radios can be active all the time, because network capacity does not directly limit the number of active radios. Since larger numbers of phones can be served by smaller numbers of cell-sites, CDMA-based standards have a significant economic advantage over TDMA-based standards, or the oldest cellular standards that used frequency-division multiplexing.

In North America, the technology competed with Digital AMPS (IS-136, a TDMA technology). It is now being supplanted by IS-2000 (CDMA2000), a later CDMA-based standard.

• Use of voice activation to reduce interference

• As data rate reduces, the transmitter can reduce the power to achieve the same error rates

• Dual Mode (AMPS/CDMA), Dual Band (900, 1900 MHz bands)

• Low power handsets (sleep mode supported)

• Soft Handoff possible

• Digital Data services (text, fax, circuit switched data)

• Advanced Telephony Features (call waiting, voice mail, etc.)

• Security: CDMA signal + CAVE encryption

• Air Interface Standard Only.