20ECD22

Hall Ticket Number:

III/IV B.Tech (Regular) DEGREE EXAMINATION

July/August, 2023 — **Electronics & Communications Engineering**

Sixth Semester — **Mobile & Cellular Communications**

Time: Three Hours — **Maximum:** 70 Marks

Answer question 1 compulsory. **(14X1 = 14Marks)**

Answer one question from each unit. **(4X14=56 Marks)**

			CO	BL	M
1	a)	Give the advantages of cell splitting.	CO1	L2	1M
	b)	What is Grade of service?	CO1	L2	1M
	c)	Give the examples of Examples of wireless communication systems?	CO1	L1	1M
	d)	Define Free space propagation model.	CO2	L2	1M
	e)	What is ground reflection (Two-Ray) model.	CO2	L2	1M
	f)	What is Fading effects due to multipath time delay spread?	CO2	L2	1M
	g)	What is Decision feedback equalization?	CO3	L2	1M
	h)	Differences between Frequency diversity and Time diversity.	CO3	L2	1M
	i)	What are First generation cellular systems?	CO4	L2	1M
	j)	What are the Key requirements of LTE design?	CO4	L2	1M
	k)	Write one difference between co-channel and adjacent channel interference.	CO1	L2	1M
	l)	What is soft Handoff?	CO1	L1	1M
	m)	What is the use of sectoring?	CO1	L1	1M
	n)	Define scattering.	CO2	L2	1M
		Unit-I			
2	a)	Elucidate the evolution of Mobile Radio Communications.	CO1	L2	7M
	b)	Discuss in detail about microcell zone concept.	CO1	L4	7M
		(OR)			
3	a)	Define Handoff. What are its types? Explain in detail.	CO1	L2	7M
	b)	Illustrate the frequency reuse concept.	CO1	L3	
		Unit-II			
4	a)	Explain about the Practical link budget design using path loss models.	CO2	L2	7M
	b)	Discuss in detail about the basic propagation mechanisms of reflection, diffraction, and scattering.	CO2	L4	7M
		(OR)			
5	a)	What is Free space propagation model and explain in detail.	CO2	L2	7M
	b)	Discuss the different types of small-scale fading.	CO2	L4	7M
		Unit-III			
6	a)	Discuss about the merits and demerits of Maximum likelihood sequence estimation (MLSE) equalizer.	CO3	L4	7M
	b)	Explain the differences between Linear equalizers and Nonlinear equalization.	CO3	L3	7M
		(OR)			
7	a)	Draw and explain about RAKE receiver.	CO3	L2	7M
	b)	Write a short note on Selection diversity and feedback or scanning diversity.	CO3	L2	7M
		Unit-IV			
8	a)	With a neat block diagram explain the architecture of GSM.	CO4	L4	7M
	b)	Explain the LTE architecture with neat sketch.	CO4	L2	7M
		(OR)			
9	a)	Discuss in detail the 2G and 3G wireless network standards. Compare the relative merits and demerits of both the standards.	CO4	L4	7M
	b)	Discuss the improvements from 1G to 4G.	CO4	L3	7M

SCHEME OF VALUTION

III/IV Regular Degree Examination, August 2023
Electronics and Communication Engineering

Mobile & Cellular Communications

[20ECD22]

Prepared by

(Dr. J. Chandrasekhar Rao)

Verified by

(HOD-ECE)

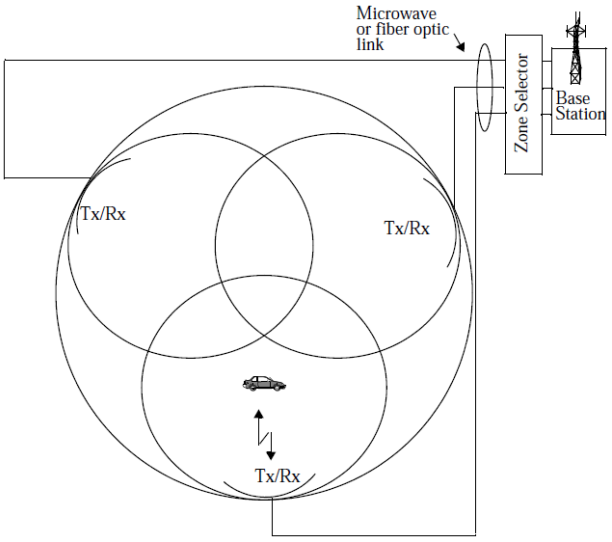
Scheme

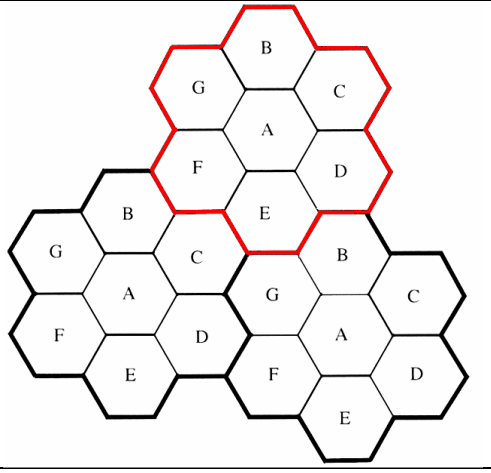
1	a)	Give the advantages of cell splitting. It Accommodate large number of users, it provides high quality service, High capacity is achieved by using cell concept.	1M
	b)	What is Grade of service? The grade of service (GOS) is a measure of the ability of a user to access a trunked system during the busiest hour.	1M
	c)	Give the examples of Examples of wireless communication systems? Paging systems, Cordless telephone systems, Cellular Telephone Systems, Hand-held walkie-talkies, Remote controllers and Garage door openers.	1M
	d)	Define Free space propagation model. The free space propagation model is used to predict received signal strength when the transmitter and receiver have a clear, unobstructed line-of-sight path between them.	1M
	e)	What is ground reflection (Two-Ray) model. The two-rays ground-reflection model is a multipath radio propagation model which predicts the path losses between a transmitting antenna and a receiving antenna when they are in line of sight (LOS).	1M 1M
	f)	What is Fading effects due to multipath time delay spread? Time dispersion due to multipath delay spread leads to flat fading or frequency selective fading.	1M
	g)	What is Decision feedback equalization? DFE Can be realized in either the direct transversal form or as a lattice filter. Once an information symbol has been detected, the ISI that it induces on future symbols can be estimated and subtracted out before detection of subsequent symbols.	1M
	h)	Differences between Frequency diversity and Time diversity. Frequency diversity transmits information on more than one carrier frequency. Time diversity repeatedly transmits information at time spacings that exceed the coherence time of the channel.	1M
	i)	What are First generation cellular systems? AMPS (Advanced Mobile Phone Service) in the United States, European Total Access Communication Systems (ETACS) in Europe and NTACS in Japan.	1M
	j)	What are the Key requirements of LTE design? Performance on Par with Wired Broadband, Flexible Spectrum Usage, Co-existence and Interworking with 3G Systems as well as Non-3GPP Systems (3GPP2 CDMA and WiMAX) and Reducing Cost per Megabyte.	1M
	k)	Write one difference between co-channel and adjacent channel interference. The interference between signals from co-channel cells is called co-channel interference. Interference resulting from signals which are adjacent in frequency to the desired signal is called adjacent channel interference.	1M
	l)	What is soft Handoff? It is defined as a soft handoff where a new connection is established before the old one is released.	1M
	m)	What is the use of sectoring? The technique for decreasing co-channel interference and thus increasing system performance by using directional antennas is called *sectoring*.	1M
	n)	Define scattering. Scattering occurs when medium has objects that are smaller or comparable to the wavelength of the signal.	1M

Unit-I

2 a) Elucidate the evolution of Mobile Radio Communications. 7M

Year	Important Milestone
Before 1892	Nikola Tesla found theoretical basis for radio communication and demonstrated radio transmission.
1897	Guglielmo Marconi demonstrated radio communications; awarded patent for it.
1902	First verifiable transatlantic radio transmission (telegraphy) made from an Italian cruiser with Marconi aboard using 272kHz signals.
1906	Reginald Fessendon made first successful two-way transmission over North Atlantic and demonstrated voice transmission using amplitude modulation.
1915	First transatlantic radio transmission of voice from Arlington, Virginia to Paris, France.
1921	Short wave radio (HF radio: 2.3MHz to 25.82MHz) developed.
1934	AM radio systems used in 194 U.S. municipalities for public safety.
1935	Edwin Armstrong demonstrated FM.
1946	First mobile telephone service in St. Louis, Missouri introduced by AT&T.
1948	Claude Shannon published his seminal theory on channel capacity; $C=B\log_2(1+SNR)$.
1956	Ericsson developed first automatic mobile phone called Mobile Telephone A (weighed 40kg).
1960–1970	Bell Labs developed cellular concept.
1971	AT&T submits proposal for a cellular mobile system concept to FCC.
1979	First commercial cellular system deployed by NTT in Japan.
1983	FCC allocated 40MHz of spectrum in 800MHz for AMPS.
1983	Advanced Mobile Phone Service (AMPS) launched in Chicago.
1989	Qualcomm proposes CDMA as a more efficient, wireless voice technology.
1991	First commercial GSM deployment in Europe (Finland).
1995	First commercial launch of CDMA (IS-95) service by Hutchinson Telecom, Hong Kong.
1995	Personal Communication Services (PCS) license in the 1800/1900MHz band auctioned in the United States.
2001	NTT DoCoMo launched first commercial 3G service using UMTS WCDMA.
2002	South Korea Telecom launches first CDMA2000 EV-DO network.
2005	UMTS/HSDPA launched in 16 major markets by AT&T.
2005	IEEE 802.16e standard, the air-interface for Mobile WiMAX, completed and approved.
2006	WiBro (uses the IEEE 802.16e air-interface) commercial services launched in South Korea.
2007	Apple iPhone launched, driving dramatic growth in mobile data consumption.
2009	3GPP Release 8 LTE/SAE specifications completed.

	b)	**Discuss in detail about microcell zone concept.**  • *Microcell-zone* concept distributes the coverage of a cell and extends the cell boundary to hard to-reach places. In this scheme, each of the three zone sites (represented as Tx/Rx in Figure) are connected to a single base station and share the same radio equipment. The zones are connected by coaxial cable, fiberoptic cable, or microwave link to the base station. Multiple zones and a single base station make up a cell. As a mobile travels within the cell, it is served by the zone with the strongest signal. As a mobile travels from one zone to another within the cell, it retains the same channel. • The base station simply switches the channel to a different zone site. The channels are distributed in time and space by all three zones and are also reused in co-channel cells. • Ex: To achieve *S/I* of 18 dB: Normal system requires D/R ratio of 4.6 with N=7. Microcell system requires D/R ratio of 3 with N=3. This reduction in the cluster size from $N = 7$ to $N = 3$ results to 2.33 times increase in capacity for a system using microcell zone concept.	7M
		(OR)	
3	**a)**	**Define Handoff. What are its types? Explain in detail.** • When a mobile moves into a different cell while a conversation is in progress, the MSC automatically transfers the call to a new channel belonging to the new base station. This procedure is called handoff. • The handoffs are of following types: i. Hard Handoff ii. Soft Handoff iii. Queued Handoff iv. Delayed Handoff v. Intersystem Handoff vi. Intrasystem Handoff vii. Network controlled Handoff (NCHO) viii. Mobile Assisted Handoff (MAHO)	7M
	b)	**Illustrate the frequency reuse concept.** The design process of selecting and allocating channel groups for all of the cellular base stations within a system is called frequency reuse or frequency planning. Consider a cellular system: • Total number of duplex channels available for use: *S* channels • Cluster size : *N* cells • No. of channels in each cell : $k=S/N$ *(where $K<S$)* • The total number of available radio channels can be expressed as $S= k*N$ • Capacity of a cluster : $C = k*N = S$ *Channels* • If a cluster is replicated *M* times, then the total capacity of the system: $C = M*k*N = M*S$	7M



Unit-II

4 a) Explain about the Practical link budget design using path loss models. 7M

i. Log-Distance Path Loss Model:

The average large-scale path loss for an arbitrary T-R separation is expressed as a function of distance by using a path loss exponent, *n*.

$$\overline{PL}(d) \propto \left(\frac{d}{d_o}\right)^n$$

$$\overline{PL}(d)[dB] = \overline{PL}(d_o)[\text{dB}] + 10n\log\left(\frac{d}{d_o}\right)$$

ii. Log-Normal Shadowing Path Loss Model

Log-distance path loss gives only the average value of path loss. It does not consider the shadowing effects.

Surrounding environment may be vastly different at two locations having the same T–R separation *d*.

More accurate model includes a random variable to account for change in environment.

$$PL(d)[\text{dB}] = \overline{PL}(d)[\text{dB}] + X_\sigma = \overline{PL}(d_0)[\text{dB}] + 10n\log\left(\frac{d}{d_0}\right) + X_\sigma$$

$$P_r(d)[\text{dBm}] = P_t(d)[\text{dBm}] - PL(d)[\text{dB}]$$

X_σ : Zero mean Gaussian random variable (dB)

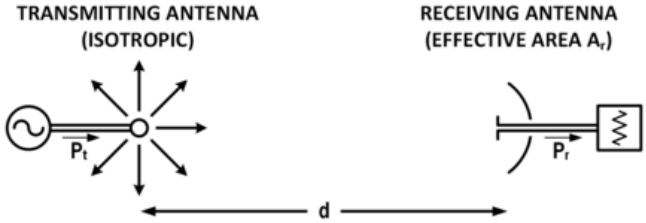
σ : Standard deviation (dB)

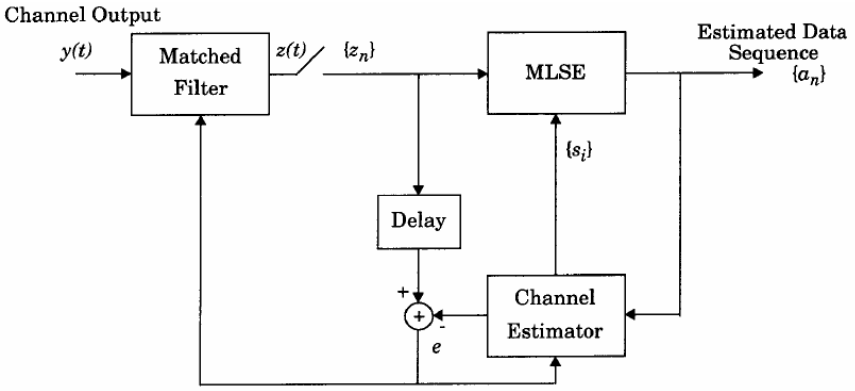
b) Discuss in detail about the basic propagation mechanisms of reflection, diffraction, and scattering. 7M

Three basic propagation mechanisms which impact the propagation in mobile radio communication system are: Reflection, Diffraction, and Scattering.

- Reflection: It occurs when a propagating electromagnetic wave impinges upon an object which has very large dimensions when compared to the wavelength of the propagating wave. Reflection occurs from the surface of earth, buildings and walls.

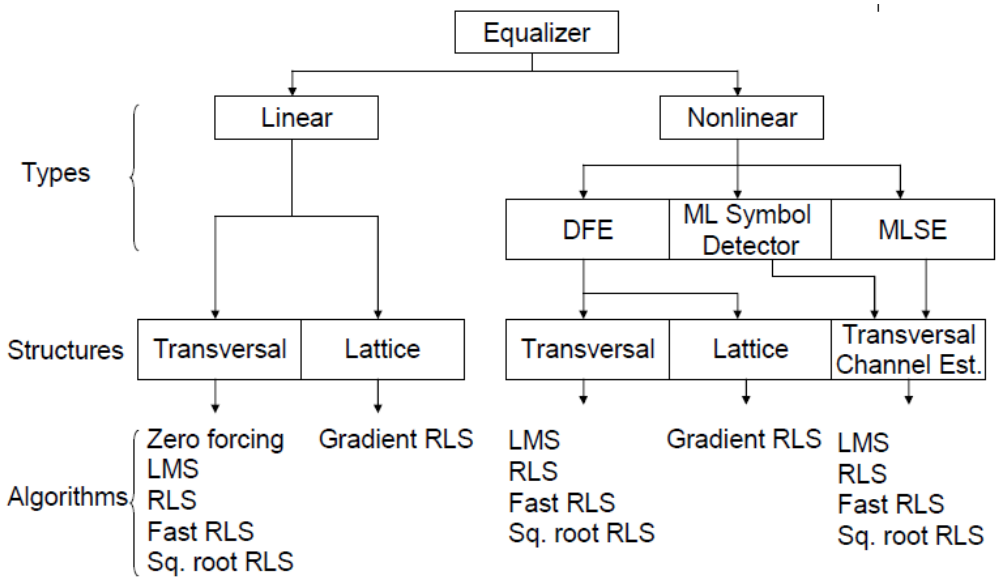
- Diffraction: It occurs when the radio transmission path between the transmitter and receiver is obstructed by a surface that has sharp irregularities (edges).
  Secondary waves resulting from the obstructing surface are present throughtout the space and even behind the obstacle.
  The secondary waves causes bending of waves around the obstacle, even when a LOS path does not exist between the transmitter and receiver.
  Bending of electromagnetic waves around sharp edges such as, sharp towers or peaks.
- Scattering: It occurs when medium has objects that are smaller or comparable to the wavelength.
  Scattered waves are produced by rough surfaces, small objects, or by irregularities in the channel, foliage, street signs etc.

		(OR)	
5	**a)**	**What is Free space propagation model and explain in detail.** • The free space propagation model is used to predict received signal strength when the transmitter and receiver have a clear, unobstructed line-of-sight path between them. • Example: Satellite communication systems and microwave line-of-sight radio links. • The free space model predicts that received power decays as a function of the T-R separation distance raised to some power (i.e., a power law function). • The free space power received by a receiver antenna which is separated from a radiating transmitter antenna by a distance *d*, is given by the *Friis free space equation*. $$P_r(d) = P_d A_e = \frac{P_t G_t G_r \lambda^2}{(4\pi)^2 d^2 L}$$  	7M
	b)	**Discuss the different types of small-scale fading.** **Small-Scale Fading** **(Based on multipath time delay spread)** **Flat Fading** 1. BW of signal < BW of channel 2. Delay spread < Symbol period **Frequency Selective Fading** 1. BW of signal > BW of channel 2. Delay spread > Symbol period **Small-Scale Fading** **(Based on Doppler spread)** **Fast Fading** 1. High Doppler spread 2. Coherence time < Symbol period 3. Channel variations faster than base-band signal variations **Slow Fading** 1. Low Doppler spread 2. Coherence time > Symbol period 3. Channel variations slower than baseband signal variations	7M
		Unit-III	
6	**a)**	**Discuss about the merits and demerits of Maximum likelihood sequence estimation (MLSE) equalizer.** **Merits of MLSE:** • MLSE tests all possible data sequences (rather than decoding each received symbol by itself) and chooses the data sequence with the maximum probability as the output. • MLSE uses various forms of the classical maximum likelihood receiver structure. • First proposed by Forney using a basic MLSE estimator structure and implementing it with the Viterbi algorithm **Demerits of MLSE:** • MLSE usually has a large computational requirement especially when the delay spread of the channel is large. • MLSE requires knowledge of the channel characteristics in order to compute the matrics for making decisions. • MLSE also requires knowledge of the statistical distribution of the noise corrupting the signal.	7M



b) **Explain the differences between Linear equalizers and Nonlinear equalization.** 7M

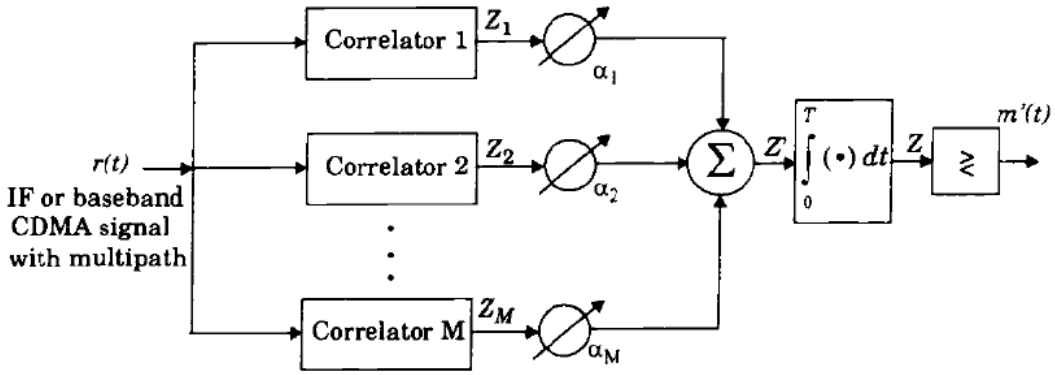
- **Equalization techniques can be subdivided into two general categories:**
  - **linear equalization**
    - *The output of the decision maker is not used in the feedback path to adapt the equalizer.*
  - **nonlinear equalization**
    - *The output of the decision maker is used in the feedback path to adapt the equalizer.*
- **Many filter structures are used to implement linear and nonlinear equalizers**
- **For each structure, there are numerous algorithms used to adapt the equalizer.**



(OR)

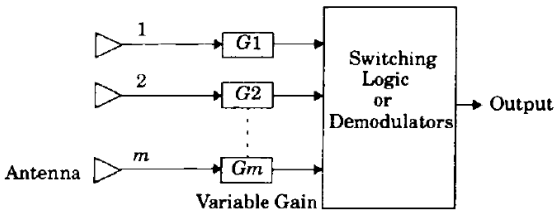
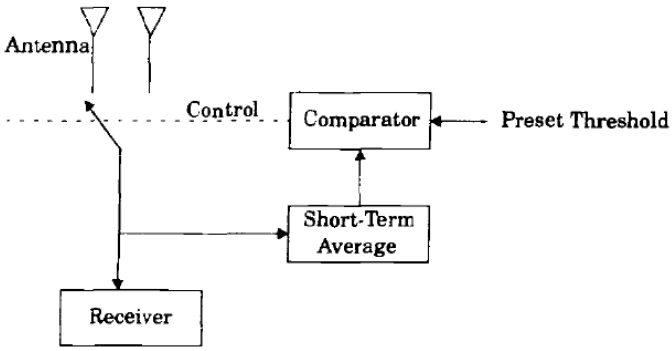
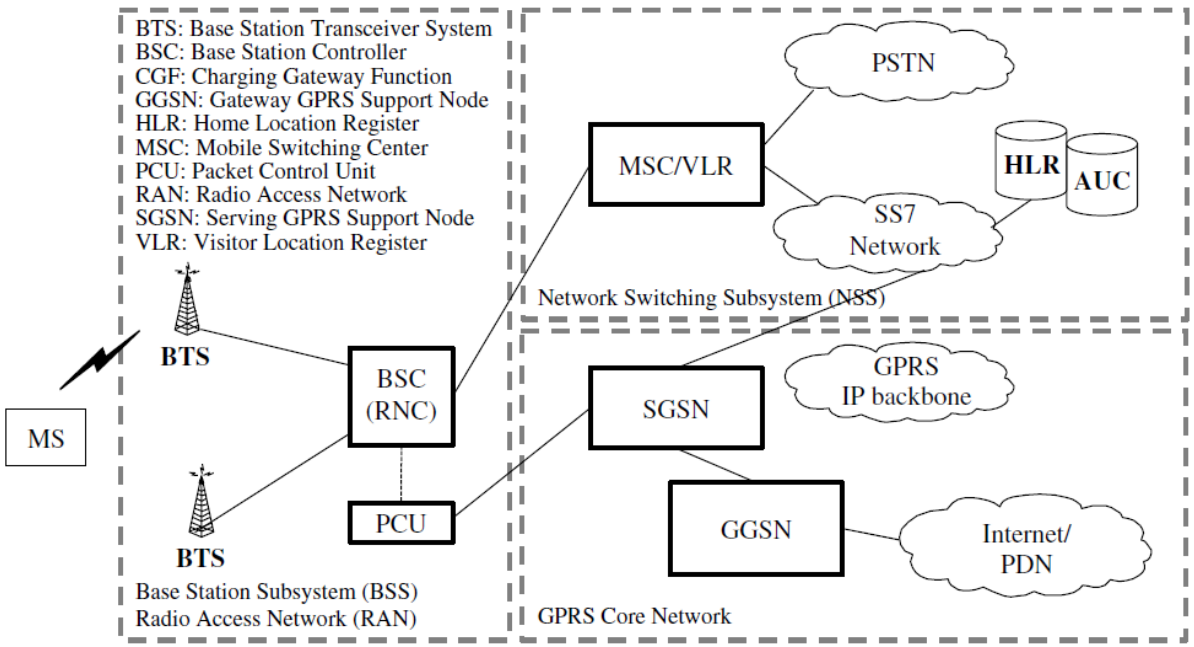
7 **a)** **Draw and explain about RAKE receiver.** 7M

- A RAKE receiver attempts to collect the time-shifted versions of the original signal by providing a separate correlation receiver for each of the multipath signals.

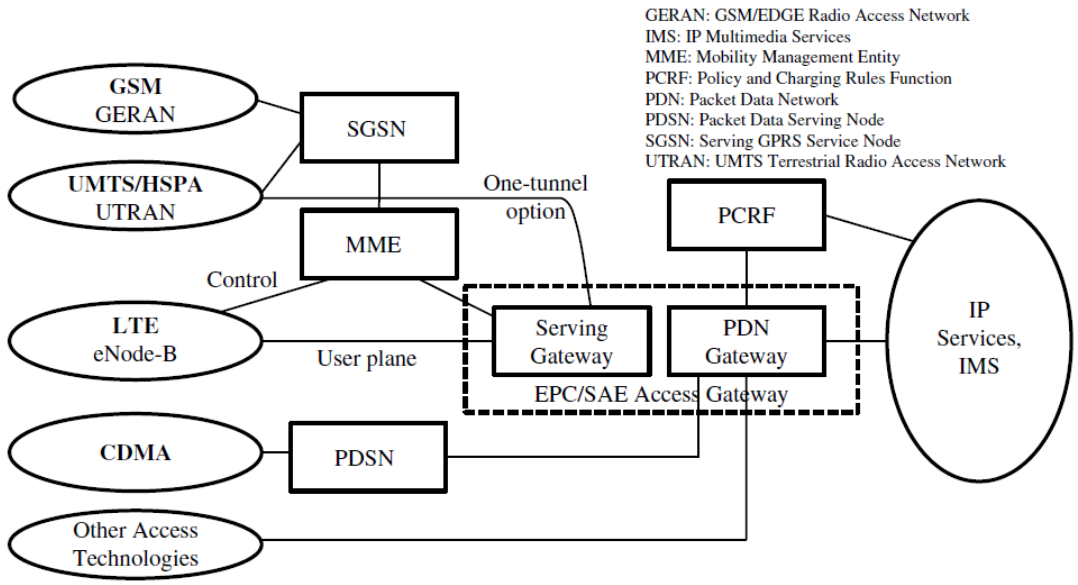


- The overall signal Z' is given by

$$Z' = \sum_{m=1}^{M} \alpha_m Z_m$$

	b)	**Write a short note on Selection diversity and feedback or scanning diversity.** **i. Selection diversity:** • The simplest diversity technique. The receiver branch having the highest instantaneous SNR is connected to the demodulator. The antenna signals themselves could be sampled and the best one sent to a single demodulator. In practice, the branch with the largest (S + N) /N is used, since it is difficult to measure SNR. **ii. Feedback or scanning diversity:** • In this diversity, the *M* signals are scanned in a fixed sequence until one is found to be above a predetermined threshold. This signal is then received until it falls below threshold and the scanning process is again initiated.  (i) Selection diversity  (ii) Feedback or scanning diversity	7M
		Unit-IV	
8	a)	**With a neat block diagram explain the architecture of GSM.** The original GSM architecture had two sub-components: i. Base Station Subsystem (BSS): This is comprised of the base-station transceiver (BTS) units that the mobile stations (MS) connect with over the air-interface and the base station controller (BSC), which manages and aggregates traffic from several BTSs for transport to the switching core, and manages mobility across BTSs connected directly to them. ii. Network Switching Sub-system (NSS): This is comprised of the Mobile Switching Center (MSC) and subscriber data bases. The MSC provides the required switching to connect the calling party with the called party and is interconnected with the Public Switched Telephone Network (PSTN). The MSC uses the Home Location Register (HLR) and Visitor Location Register (VLR) to determine the location of mobile subscribers for call control purposes.  	7M

	b)	**Explain the LTE architecture with neat sketch.**	7M



- The EPC includes four new elements:
  - i. Serving Gateway (SGW), which terminates the interface toward the 3GPP radio access networks;
  - ii. Packet Data Network Gateway (PGW), which controls IP data services, does routing, allocates IP addresses, enforces policy, and provides access for non-3GPP access networks;
  - iii. Mobility Management Entity (MME), which supports user equipment context and identity as well as authenticates and authorizes users;

Policy and Charging Rules Function (PCRF), which manages QoS aspects.

(OR)

9	**a)**	**Discuss in detail the 2G and 3G wireless network standards. Compare the relative merits and demerits of both the standards.**	7M

No	2G	3G
1	2G is short for second-generation cellular technology.	3G, short for third generation, is the third generation of wireless mobile telecommunications technology.
2	2G technology offers a low level of security	3G technology offers a high level of security as compared to 2G technology
3	The downloading and uploading speeds available in 2G technologies are up to 236 Kbps.	3G technology the downloading and uploading speeds are up to 21 Mbps and 5.7 Mbps respectively.
4	Uses TDMA, CDMA	Uses CDMA2000, UMTS, EDGE
5	Was first commercially used in Finland	Was first commercially used in Japan
6	Narrowband internet service	Broadband internet service
7	Operating frequency between 800-1800 Mhz	Operating frequency is 2100 Mhz
8	Carrier frequency is 200khz	Carrier frequency is 5Mhz
9	Disadvantages • Low network range • Slow data rate	Disadvantages • High power consumption • Low network coverage, High cost

	b)	**Discuss the improvements from 1G to 4G.**	7M

Technologies / Features	*1G*	*2G/2.5G*	*3G*	*4G*
Evolution	1970	1980	1990	2000
Deployment	1984	1999	2002	2010
Data Rate	2 kbps	14.4-64 kbps	2 Mbps	200 Mbps to 1 Gbps for low mobility
Famous Standards	AMPS	2G: GSM,C]DMA 2.5G: GPRS, EDGE, 1xRTT	WCDMA, CDMA-2000	LTA, WiMAX
Technology behind	Analog cellular technology	Digital cellular technology	Broad bandwidth CDMA, IP technology	Undefined IP and seamless combination of broadband. LAN/WAN/PAN/ WLAN
Service	Voice	2G: Digital Voice, SMS 2.5G: Voice+Data	Integrated high quality audio, video and data	Dynamic information access, wearable devices
Multiplexing	FDMA	TDMA,CDMA	CDMA	CDMA
Type of Switching	Circuit	2G: Circuit 2.5G: Circuit and packet	Packet	Packet
Handoff	Horizontal	Horizontal	Horizontal	Horizontal and Vertical
Core Network	PSTN	PSTN	Packet network	Internet