SRM Institute of Science and Technology
College of Engineering and Technology

Set A QP

DEPARTMENT OF ECE

SRM Nagar, Kattankulathur – 603203, Chengalpattu District, TamilNadu

Academic Year: 2022-2023 (ODD SEM)

Test: CLAT 3 (Batch 1 – 8.00am to 9.40am) **Date: 08.11.2023**
Course Code & Title: 18ECC301T Wireless Communication **Duration: 2 periods**
Year & Sem: IV Year / 7th **Max. Marks: 50**

Course Articulation Matrix: ***(to be placed)***

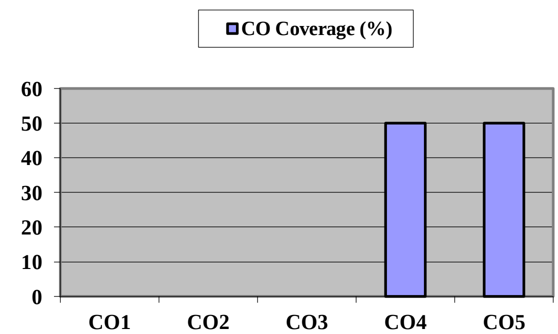
	18ECC301T - Wireless Communication	**Program Outcomes (POs)**														
		Graduate Attributes												**PSO**		
COs	**Course Outcomes (COs)**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1	Interpret the concepts of Wireless communication and basic cellular networks	3	-	-	3	-	-	-	-	-	-	-	2	-	-	-
CO-2	Analyze different Radio wave propagation models for cellular communication	-	3	-	3	-	-	-	-	-	-	-	-	-	-	3
CO-3	Apply different multipath propagation channel models in wireless systems	-	3	3	-	-	-	-	-	-	-	-	-	-	-	2
CO-4	Illustrate the Link performance improvement techniques	-	3	-	-	-	-	2	-	-	-	-	-	-	-	3
CO-5	Summarize different wireless communication standards and systems	-	-	2	-	-	2	-	-	-	-	-	-	2	-	-

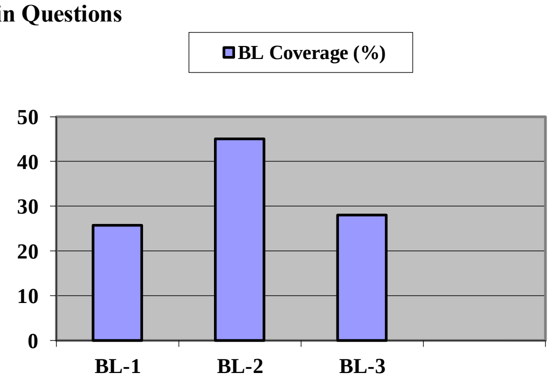
Part A (10 X 1 = 10 marks)
Answer All Questions

Q. No	**Question**	**Marks**	**BL**	**CO**	**PO**
1	In maximal ratio combining the output SNR is equals to a) Mean of all individual SNRs b) Maximum of all SNRs c) Sum of individual SNR d) Minimum of all SNRs	**1**	**1**	**4**	**7**
2	Which of these is a necessary condition for optimal power allocation? a) Average transmit power is constant b) Channel state information known at the transmitter c) Channel state information known at the receiver d) Increased transmit power	**1**	**1**	**4**	**7**
3	If the channel is bandlimited to 6 kHz & signal to noise ratio is 16, what would be the capacity of channel? a) 15.15 kbps b)30.12 kbps c)43.24 kbps d)24.52 kbps	**1**	**1**	**4**	**2**
4	A RAKE receiver collects the ___________ versions of the original signal a)Time shifted b) Amplitude shifted c)Frequency shifted d) Phase shifted	**1**	**1**	**4**	**2**
5	Equalization is used to compensate ___________. a)Peak signal to noise ratio b)Inter symbol interference c)Channel fading d)Noises present in the signal	**1**	**1**	**4**	**2**
6	A hyper frame in GSM, consists of ---------------- super frames a) 256 b)512 c)1024 d)2048	**1**	**1**	**5**	**6**
7	ISI occur only when ____ offset differs from CP duration. a) Time b) Space c)Frequency d) Code	**1**	**1**	**5**	**3**
8	The troubles that OFDM faces over other spread spectrum techniques are 1. Sensitivity to Doppler shift 2. Frequency synchronization problems 3. Time synchronization problems 4. Low efficiency due to guard intervals	**1**	**1**	**5**	**3**

	a) 1,2 and 3 are correct b) 2 and 3 are correct c) 1, 2 and 4 are correct d) 1 and 3 are correct				
9	In IS-95 the forward and reverse channel pair is separated by ----- a) 45KHz b) 45MHz c) 35 KHz d) 35 MHz	**1**	**1**	**5**	**6**
10	In GSM super frame how many multi frames are available? a) 51 b) 29 c) 53 d) 26	**1**	**1**	**5**	**3**
	Part – B1 **(2 × 4 = 8 Marks)** **Instructions: Answer any TWO Questions.**				
11	Recall Selection and Combining Diversity, give advantage and disadvantage.	**4**	**2**	**4**	**2**
12	Consider a wireless channel where power falloff with distance follows the formula P r (d)=Pt (d_0/d)3 for d_0 = 10 m. Assume the channel has bandwidth B = 30 kHz and AWGN with noise PSD $N_0/2$, where $N_0 = 10^{-9}$ W/ Hz. For a transmit power of 1 W, find the capacity of this channel for a transmit–receive distance of 100 m and 1 km.	**4**	**2**	**4**	**2**
13	Draw the block diagram of Adaptive equalizer.	**4**	**1**	**4**	**2**
	Part – B2 **(2 × 4 = 8 Marks)** **Instructions: Answer any TWO Questions.**				
14	State the advantages and disadvantages of OFDM, give some popular standards that use OFDM	**2+2**	**3**	**5**	**3**
15	List the forward link channels in CDMA IS -95 and also specify its use.	**4**	**2**	**5**	**3**
16	Detail the GSM services available.	**4**	**1**	**5**	**6**
	Part – C (2 × 12 = 24 Marks)				
17	a) Elaborate the working principle of RAKE receiver in CDMA systems with a neat sketch.	**12**	**3**	**4**	**7**
	OR				
	b) Explain the following combining techniques with neat diagram: i) maximal ratio combining ii) equal gain combining	**6+6**	**3**	**4**	**7**
18	a)i)Discuss elaborately the GSM Architecture and interfaces with necessary diagram. ii)If a normal GSM time slot consists of 6 trailing bits, 8.25 guard bits, 26 training bits, and 2 traffic bursts of 58 bits of data, find the frame efficiency.	**10+2**	**3**	**5**	**6**
	OR				
	b) Elucidate in detail the OFDM Transmitter and Receiver block diagrams, summarize its working principle.	**12**	**3**	**5**	**6**

Course Outcome (CO) and Bloom's level (BL) Coverage in Questions





Evaluation Sheet

Name of the Student:
Register No.:

Part- A (10 * 1= 10 Marks)					
Q. No	**CO**	**PO**	**Max. Marks**	**Mark Obtained**	**Total**
1	4	7	1		
2	4	2	1		
3	4	7	1		
4	4	2	1		
5	4	2	1		
6	5	6	1		
7	5	3	1		
8	5	3	1		
9	5	6	1		
10	5	3	1		
Part- B1 (2*4= 8 Marks)					
11	4	2	4		
12	4	2	4		
13	4	2	4		
Part- B2 (2*4= 8 Marks)					
14	5	3	4		
15	5	3	4		
16	5	6	4		
Part – C (2 × 12 = 24 Marks)					
17a	4	7	12		
17b	4	7	12		
18a	5	6	12		
18b	5	6	12		

Consolidated Marks:

CO	Max.Marks	Mark Obtained
4	41	
5	41	
Total	82	

PO	Max.Marks	Mark Obtained
2	15	
3	11	
6	30	
7	26	
Total	82	

Signature of the Course Teacher

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Set A
Ans Key

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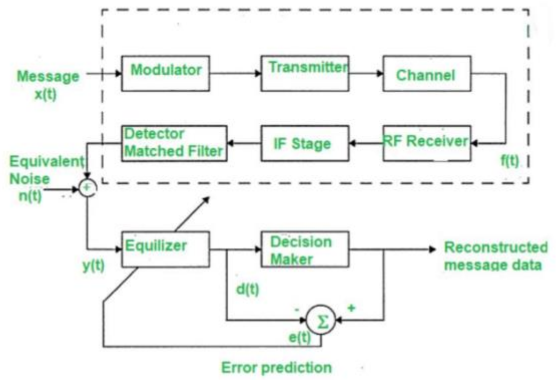
CO-3	Apply different multipath propagation channel models in wireless systems	-	3	3	-	-	-	-	-	-	-	-	-	-	-	2
CO-4	Illustrate the Link performance improvement techniques	-	3	-	-	-	-	2	-	-	-	-	-	-	-	3
CO-5	Summarize different wireless communication standards and systems	-	-	2	-	-	2	-	-	-	-	-	-	2	-	-

Part A (10 X 1 = 10 marks)
Answer All Questions

Q. No	Question	Marks	BL	CO	PO
1	c)	1	1	4	7
2	b)	1	1	4	7
3	d)	1	1	4	2
4	a)	1	1	4	2
5	b)	1	1	4	2
6	d)	1	1	5	6
7	a)	1	1	5	3
8	c)	1	1	5	3
9	b)	1	1	5	6
10	a) Or d)	1	1	5	3
Part – B1 (2 × 4 = 8 Marks) Instructions: Answer any TWO Questions.					
11	**Selection diversity**: In selection diversity the best signal copy is selected and processed (demodulated and decoded), while all other copies are discarded. Advantage: Requires only one RF (down conversion) chain. Disadvantage: Selection diversity wastes signal energy by discarding copies of the received signal **Combining diversity**: In combining diversity all copies of the signal are combined (before or after the demodulator), and the combined signal is decoded. Advantage: Combining diversity leads to better performance, as all available information is exploited. Disadvantage: It requires a more complex RX than selection diversity. A RX with combining diversity needs to down convert all available signals, and combine them	4	2	4	2

	appropriately in the baseband. Thus, it requires antenna elements as well as complete Radio Frequency (RF) (down conversion) chains.				
12	Soln for $d = 1km = 1000\,m$ $\gamma = \frac{P_r(d)}{N_0 B}$ $P_r(d) = P_t (d_0/d)^3$ $= \left(\frac{10}{1000}\right)^3$ $= 0.01^3$ $\therefore \gamma = \frac{0.01^3}{10^{-9} \times 30 \times 10^3} = 0.033 = -15\,dB$ $C = B \log_2(1+\gamma)$ $= 30000 \log_2 (1+0.33)$ $C = 1.4\,kbps$ for $d = 100\,m$. $P_r(d) = P_t (d_0/d)^3$ $= \left(\frac{10}{100}\right)^3 = 0.1^3$ $\gamma = \frac{0.1^3}{10^{-9} \times 30 \times 10^3} = 33 = 15\,dB$ $C = B \log_2(1+\gamma)$ $C = 152.6\,kbps$. Significant decrease in capacity at greater distances due to the path loss exponent of 3, which greatly reduces received power as distance increases.	**4**	**2**	**4**	**2**
13	Draw the block diagram of Adaptive equalizer  	**4**	**1**	**4**	**2**
	Part – B2 **(2 × 4 = 8 Marks)** **Instructions: Answer any TWO Questions.**				
14	**Advantages of OFDM :** More resistance to frequency selective fading Very resilient to inter-symbol and inter-frame interference Efficient use of the available spectrum using close-spaced overlapping sub-carriers Eliminates ISI and IFI by the use of a cyclic prefix High transmission bit rates Low sensitivity to time synchronization error **Disadvantages of OFDM** Require highly linear amplifier Sensitive to carrier offset and drift Sensitive to frequency synchronization problems Inter-carrier interference between the sub-carrier Loss of efficiency caused by cyclic prefix or guard of interval High power transmitter amplifier needs linearization High peak to average power ratio	**2+2**	**3**	**5**	**3**

	Popular Standards -802.11a/g/n WLAN -802.16e/WiMAX -LTE -DVB-T/H -ATSC-M/H				
15	List and present the use of forward link channels in CDMA IS -95 • Pilot channel – Provides a reference to all signals (beacon) • Sync channel – Used for obtaining timing information • Paging channel – Used to "page" the mobile terminal when there is an incoming call • Traffic channel – Carries actual voice or data traffic : fundamental code channel	**4**	**2**	**5**	**3**
16	Detail the GSM services available. **Telephonic Services** ➢ Includes emergency calling and facsimile. ➢ GSM also supports videotex and Telex though they are not integral part of GSM **Bearer Services or Data Services** ➢ These are limited to layer 1,2 and 3 of open system interconnection (OSI)reference model. ➢ Supported services include packet switched protocols and data rates from 300 bps to approx. 9.6 kbps. ➢ Data may be transmitted using either transparent (GSM provides standard channel coding) or non-transparent mode (GSM provides special coding based on particular data interface) **Supplementary ISDN Services** ➢ Supplementary ISDN services, are digital in nature, and include call diversion, closed user groups, and caller identification, and are not available in analog mobile networks. ➢ Supplementary services also include the short messaging service (SMS) which allows GSM subscribers and base stations to transmit alphanumeric pages of limited length while simultaneously carrying normal voice traffic. ➢ SMS also provides cell broadcast, which allows GSM base stations to repetitively transmit ASCII messages in concatenated fashion. ➢ SMS may be used for safety and advisory applications, such as the broadcast of highway or weather information to all GSM subscribers within	**4**	**1**	**5**	**6**
Part – C (2 × 12 = 24 Marks)					
17	a)Elaborate the working principle of RAKE receiver in CDMA systems with a neat sketch. **Explanation: 8 marks** **Diagram: 4 marks** Rake Receiver is used in CDMA-based Code Division Multiple Access systems and can combine multipath components, which are time-delayed versions of the original signal transmission. Combining is done in order to improve the signal to noise ratio at the receiver. 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. This can be done due to multipath components are practically uncorrelated from another when their relative propagation delay exceeds a chip period. Due to reflections from obstacles a radio channel can consist of many copies of originally transmitted signals having different amplitudes, phases, and delays. If the signal components arrive more than duration of one chip apart from each other, a RAKE receiver can be used to resolve and combine them. The RAKE receiver uses a multipath diversity principle. Multipath can occur in radio channel in various ways such as, reflection and diffraction from buildings, and scattering from trees .	**12**	**3**	**4**	**7**

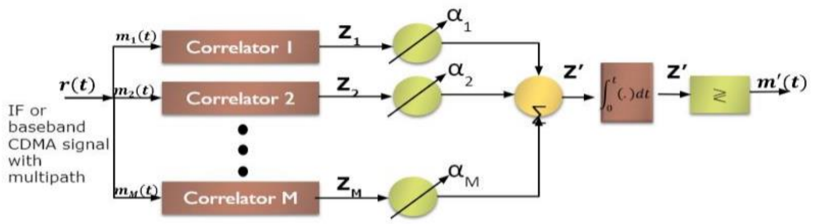
Each correlator detects a time shifted version of the original CDMA transmission.

Each finger of the RAKE correlates to a portion of the signal which is delayed by at least one chip in time from the other fingers.

- M branches or "fingers" = # of correlation Rx's
- Separately detect the M strongest signals
- Weighted sum computed from M branches
  - faded signal → low weight
  - strong signal → high weight
  - overcomes fading of a signal in a **single** branch

***Rake receiver is a** radio receiver designed to counter the effects of multipath fading. It does this by using several "sub-receivers" called fingers, that is, several correlators each assigned to a different multipath component.*

➢ An M-branch or M-Finger RAKE receiver implementation



$$Z' = \sum_{m=1}^{M} \alpha_m Z_m \qquad \alpha_m = \frac{Z_m^2}{\sum_{m=1}^{M} Z_m^2}$$

OR

b) Explain the following combining techniques with neat diagram:

i) maximal ratio combining **(explanation 4 marks diag: 2 marks)**

ii) equal gain combining **(explanation 4 marks diag: 2 marks)**

Maximal Ratio Combining Technique:

Signal from all of the N-branches are weighted according to the SNR's and then summed.

Signal must be co-phased.

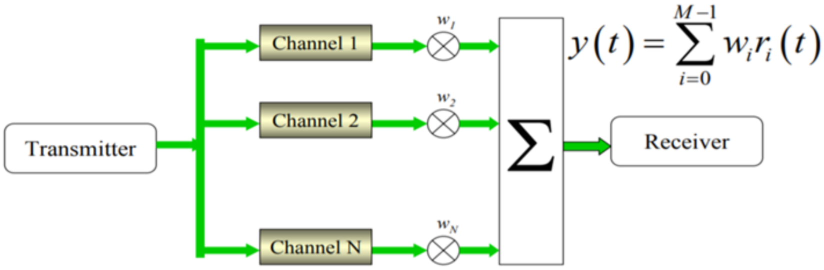
Output SNR = Sum of the individual SNR's

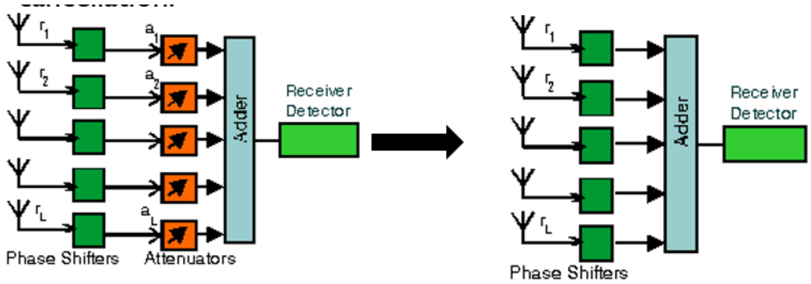
The concept of this method is that all the branch signals [N] are combined coherently with necessary weighting coefficients for every diversity branch signal so that the reduction of fading will be better leading to overall improvement of system performance. A block diagram for this method is shown in the figure below. Unlike selection diversity, the signals are co-phased before the addition process and for this, individual receiver and phasing circuits are a must for all the antenna elements. In the output, signal of maximal ratio combiner will be such that the sum of individual signal to noise ratio (SNR) values will be equal to the SNR of output signal measured Maximal ratio combiner generates an acceptable SNR value.

Accuracy is high.

Produces the best reduction of fading

6+6	3	4	7



	Weight branches for maximum SNR MRC produces an output SNR equal to sum of the individual SNR. It produces an output with an acceptable SNR even when none of the individual signals are themselves acceptable **Equal gain combining technique**: Branch weight are all set to unity. Signal from each antenna is co-phased. Make use of energy in all branches. Performance is marginally inferior to MRC and superior to selection diversity. In the equal gain combining, all the diversity branches are coherently added with a same weighting factor. On the other hand, this scheme also co-phases all the diversity branches and finally adds them up. As the signals are co-phased from all branches, they provide an equal gain factor. When compared to maximal ratio combining, the configuration of this method is simple. By applying equal gain combining, it is convenient for the receiver to get back the signals.  In EGC, each signal branch weighted with the same factor, irrespective of the signal amplitude. However, co-phasing of all signal is needed to avoid signal cancellation. EGC is simpler to implement than MRC. The adaptively controller amplifiers / attenuators are not needed. No channel amplitude estimation is needed				
18	a)i)Discuss elaborately the GSM Architecture and interfaces with necessary diagram. **GSM Architecture Explanation: 4 marks** **Diagram: 4 marks** **GSM interfaces: 2 marks** **Problem : 2 marks** **GSM System Architecture**: It consists of three major interconnected subsystems that interact between themselves. – Base Station Subsystem (BSS) – Network and Switching Subsystem (NSS) – Operation Support Subsystem(OSS) **Base Station Subsystem (BSS)** ➢ It is also known as the radio subsystem, provides and manages radio transmission paths between the mobile stations and the Mobile Switching Center(MSC). ➢ It manages the radio interface between the mobile stations and all other subsystems of GSM. ➢ Each BSS consists of many Base Station Controllers (BSCs) which connect the MS to the NSS via the MSCs. ➢ The BSS consists of many BSCs which connect to a single MSC, and each BSC typically controls up to several hundred Base Transceiver Stations (BTSs). ➢ Some of the BTSs maybe co-located at the BSC, and others may be remotely distributed and physically connected to the BSC by microwave link or dedicated leased lines. ➢ Mobile handoffs between two BTSs under the control of the same BSC are handled by the BSC, and not the MSC. This greatly reduces the switching burden of the MSC.	**10+2**	**3**	**5**	**6**

Network and Switching Subsystem (NSS)

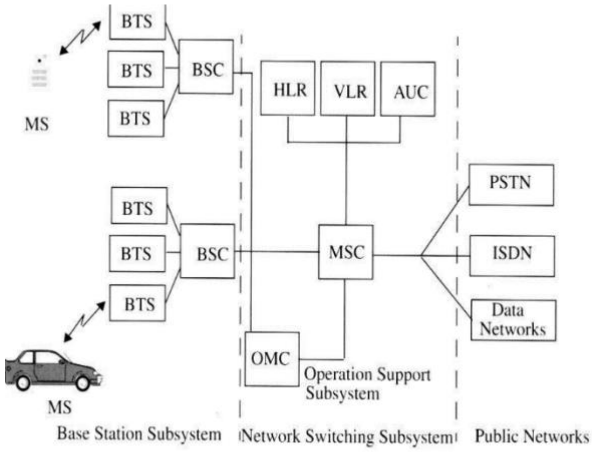
- The NSS manages the switching functions of the system and allows the MSCs to communicate with other networks such as the PSTN and ISDN.
- Handles the switching of GSM calls between external networks and the BSCs in the radio subsystem.
- Responsible for managing and providing external access to several customer databases.
- The MSC is the central unit in the NSS and controls the traffic among all of the BSCs.
- NSS contains three different data bases:
  - Home Location Register (HLR)
  - Visitor Location Register (VLR)
  - Authentication Center (AUC)

The OSS has three main functions:

Maintain all telecommunications hardware and network operation.

Manage all charging and billing procedures.

Manage all mobile equipment in the system.



GSM Interfaces

1. GSM radio air interface
2. Abis Interface
3. A interface
4. SS7

The interface which connects a BTS to a BSC is called the Abis interface. The Abis interface carries traffic and maintenance data, and is specified by GSM to be standardized for all manufacturers.

The interface between a BSC and a MSC is called the A interface, which is standardized within GSM.

The A interface uses an SS7 protocol called the Signaling Correction Control Part (SCCP) which supports communication between the MSC and the BSS, as well as network messages between the individual subscribers and the MSC.

ii)If a normal GSM time slot consists of 6 trailing bits, 8.25 guard bits, 26 training bits, and 2 traffic bursts of 58 bits of data, find the frame efficiency.

Solution:

A time slot has 6 + 8.25 + 26 + 2(58) = 156.25 bits.

A frame has 8x 156.25 = 1250 bits/frame.

The number of overhead bits per frame is given by

$B_{OH} = 8(6) + 8(8.25) \div 8(26) = 322$ bits

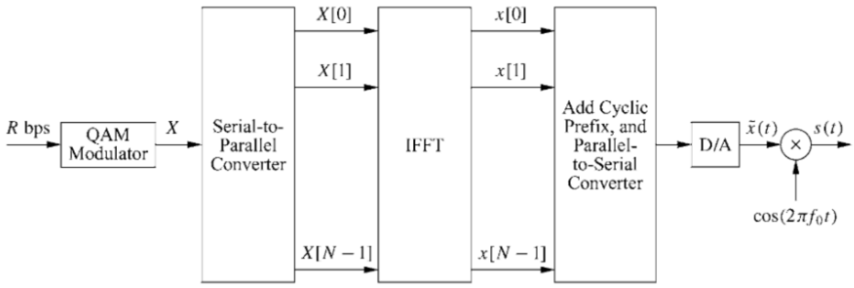
Thus, the frame efficiency η_F = (1- (322/1250)) X100= 74.24%

OR

	b) Elucidate in detail the OFDM Transmitter and Receiver block diagrams, summarize its working principle.	**12**	**3**	**5**	**6**

Explanation: 6 marks
Diagrams : 6 marks

<u>Orthogonal Frequency Division Mutiplexing (OFDM) Transmitter</u>

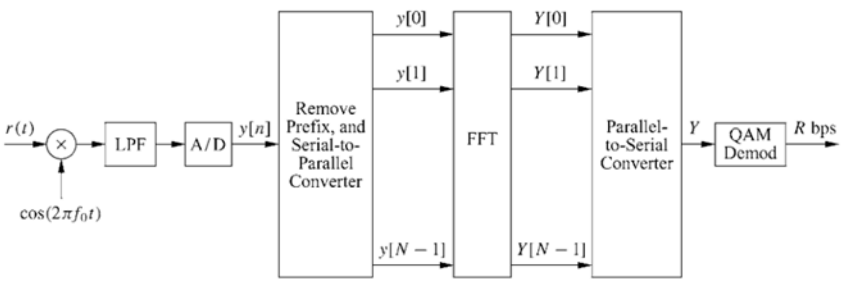


This symbol stream is passed through a serial-to-parallel converter, whose output is a set of N parallel QAM symbols X[0], . . . , X[N − 1] corresponding to the symbols transmitted over each of the subcarriers.
Thus, the N symbols output from the serial-to-parallel converter are the discrete frequency components of the OFDM modulator output s(t).
In order to generate s(t), the frequency components are converted into time samples by performing an inverse DFT on these N symbols, which is efficiently implemented using the IFFT algorithm.
The IFFT yields the OFDM symbol consisting of the sequence
x[n] = x[0], . . . , x[N − 1] of length N, where

$$x[n] = \frac{1}{\sqrt{N}} \sum_{i=0}^{N-1} X[i] e^{j2\pi ni/N}, \quad 0 \le n \le N-1.$$

This sequence corresponds to samples of the multicarrier signal: the multicarrier signal consists of linearly modulated subchannels,
The right side of above equation corresponds to samples of a sum of QAM symbols X[i] each modulated by the carrier $e^{j2\pi it/N}$, i = 0, . . . , N −1.
The cyclic prefix is then added to the OFDM symbol, and the resulting time samples $\tilde{x}[n] = \tilde{x}[-\mu], \ldots, \tilde{x}[N-1] = x[N-\mu], \ldots, x[0], \ldots, x[N-1]$ are ordered by the parallel-to-serial converter and passed through a D/A converter, resulting in the baseband OFDM signal $\tilde{x}(t)$, which is then upconverted to frequency f_0.

<u>OFDM Receiver</u>



The transmitted signal is filtered by the channel impulse response and corrupted by additive noise, resulting in the received signal r(t).

This signal is down converted to baseband and filtered to remove the high-frequency components. The A / D converter samples the resulting signal to obtain

$y[n] = \tilde{x}[n] * h[n] + \nu[n], -\mu \le n \le N-1$, where h[n] is the discrete-time equivalent low pass impulse response of the channel. The prefix of y[n] consisting of the first μ samples is then removed.

This results in N time samples whose DFT in the absence of noise is $Y[i] = H[i]X[i]$.

These time samples are serial-to-parallel converted and passed through an FFT.

This results in scaled versions of the original symbols $H[i]X[i]$, where $H[i] = H(f_i)$ is the flat fading channel gain associated with the ith subchannel.

The FFT output is parallel to-serial converted and passed through a QAM demodulator to recover the original data

The OFDM system effectively decomposes the wideband channel into a set of narrowband orthogonal subchannels with a different QAM symbol sent over each subchannel.

Knowledge of the channel gains $H[i], i = 0, \ldots, N-1$, is not needed for this decomposition, in the same way that a continuous-time channel with frequency response H(f) can be divided into orthogonal subchannels without knowledge of H(f) by splitting the total signal bandwidth into nonoverlapping subbands.

The demodulator can use the channel gains to recover the original QAM symbols by dividing out these gains: $X[i] = Y[i]/H[i]$.

This process is called frequency equalization

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Set B

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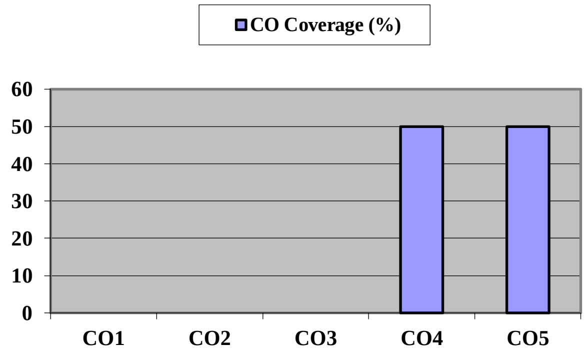
CO-2	Analyze different Radio wave propagation models for cellular communication	-	3	-	3	-	-	-	-	-	-	-	-	-	-	3
CO-3	Apply different multipath propagation channel models in wireless systems	-	3	3	-	-	-	-	-	-	-	-	-	-	-	2
CO-4	Illustrate the Link performance improvement techniques	-	3	-	-	-	-	2	-	-	-	-	-	-	-	3
CO-5	Summarize different wireless communication standards and systems	-	-	2	-	-	2	-	-	-	-	-	-	2	-	-

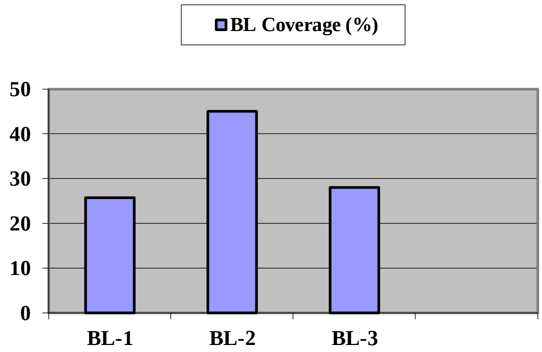
Part A (10 X 1 = 10 marks)
Answer All Questions

Q. No	Question	Marks	BL	CO	PO
1	With the same average SNR, the Shannon capacity of a fading channel with only receiver CSI is ______________ the Shannon capacity of an AWGN channel. a) Greater Than b) Greater than or Equal to b) Equal to d) Less than	1	1	4	7
2	The capacity of this channel is given by a) $C = B\log(1+P/N_0B)$ b) $C = B\log(1+P/2N_0B)$ $C = B2\log(1+P/2N_0B)$ d) $C = B\log_2(1+P/N_0B)$	1	1	4	7
3	What capacity is defined as the maximum rate that can be transmitted over a channel with some outage probability corresponding to the probability that the transmission cannot be decoded with negligible error probability a) Shannon Capacity b) Outage Capacity c) Ergodic capacity d) Channel Capacity	1	1	4	2
4	RAKE receiver uses separate __________ to provide the time shifted version of the signal. a) IF receiver b) Equalizer c) Correlation receiver d) Channel	1	1	4	2
5	Flat fading channel is also known as ________________. a) Amplitude varying channel b) Wideband channel c) Phase varying channel d) Frequency varying channel	1	1	4	2
6	______ manages the switching function in GSM.	1	1	5	6

	a) Mobile Switching center b) Operation Support Subsystem c) Network and Switching Subsystem d)Base Station Subsystem				
7	ISI occur only when ____ offset differs from CP duration. a) Time b) Space c)Frequency d) Code	**1**	**1**	**5**	**3**
8	Associate the technique which demands strict synchronization in frequency & time to preserve orthogonality? a) OFDM b) FDMA c) TDMA d) SDMA	**1**	**1**	**5**	**3**
9	IS-95 channel occupies _______ of spectrum on each one-way link. a) 2.5 KHz b) 1.25MHz c) 12.5 KHz d) 1.25 KHz	**1**	**1**	**5**	**6**
10	In GSM multiframe how many frames are available? a) 29 b) 28 c) 27 d) 26	**1**	**1**	**5**	**3**
Part – B1 **(2 × 4 = 8 Marks)** **Instructions: Answer any TWO Questions.**					
11	Explain the following diversity techniques: i) Time diversity ii) Interleaving	**4**	**2**	**4**	**2**
12	Mention the need of an Equalizer in a communication system.	**4**	**2**	**4**	**2**
13	Describe outage probability and multiplexing gain of a MIMO channel	**4**	**1**	**4**	**2**
Part – B2 **(2 × 4 = 8 Marks)** **Instructions: Answer any TWO Questions.**					
14	Draw the GSM frame structure. How many frames are made into multi, super and hyper frames?	**4**	**3**	**5**	**3**
15	Explain with diagram the receiver operation of OFDM system	**4**	**2**	**5**	**3**
16	List out the importance of Cyclic Prefix in OFDM system	**4**	**1**	**5**	**6**
Part – C (2 × 12 = 24 Marks)					
17	a) Explain the working principle of RAKE receiver in CDMA systems with a neat block diagram OR b) Explain the following combining techniques with neat diagram: i) Selection combining ii) Feedback combining	**12**	**3**	**4**	**7**
18	a) i)If GSM uses a frame structure where each frame consists of S time slots, and each time slot contains 156.25 bits, and data is transmitted at 270.833 kbps in the channel, find (a) the time duration of a bit, (b) the time duration of a slot,(c) the time duration of a frame, and(d) how long must a user occupying a single time slot must wait between two simultaneous transmissions. ii)With a neat block diagram GSM operation from speech input to speech output. OR b) Explain in detail about IS-95 forward channel with relevant block diagram.	**4** **8** **12**	**3**	**5**	**6**

Course Outcome (CO) and Bloom's level (BL) Coverage in Questions





Approved by the Course Coordinator

Evaluation Sheet

Name of the Student:
Register No.:

Part- A (10 * 1= 10 Marks)					
Q. No	CO	PO	Max. Marks	Mark Obtained	Total
1	4	7	1		
2	4	2	1		
3	4	7	1		
4	4	2	1		
5	4	2	1		
6	5	6	1		
7	5	3	1		
8	5	3	1		
9	5	6	1		
10	5	3	1		
Part- B1 (2*4= 8 Marks)					
11	4	2	4		
12	4	2	4		
13	4	2	4		
Part- B2 (2*4= 8 Marks)					
14	5	3	4		
15	5	3	4		
16	5	6	4		
Part – C (2 × 12 = 24 Marks)					
17a	4	7	12		
17b	4	7	12		
18a	5	6	12		
18b	5	6	12		

Consolidated Marks:

CO	Max.Marks	Mark Obtained
4	41	
5	41	
Total	82	

PO	Max.Marks	Mark Obtained
2	15	
3	11	
6	30	
7	26	
Total	82	

Signature of the Course Coordinator **Signature of the Course Teacher**

SRM Institute of Science and Technology
College of Engineering and Technology

DEPARTMENT OF ECE

SRM Nagar, Kattankulathur – 603203, Chengalpattu District, Tamilnadu

Academic Year: 2022-23 (ODD)

OFFLINE
SET B

Test: CLAT-3 **Date: 8/11/2023**
Course Code & Title: 18ECC301T, WIRELESS COMMUNICATION
Duration: 2 Period
Year & Sem: IV & VII **Max. Marks: 50**

Course Articulation Matrix:

	18ECC301T - Wireless Communication	**Program Outcomes (POs)**														
		Graduate Attributes												**PSO**		
COs	**Course Outcomes (COs)**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO-1	Interpret the concepts of Wireless communication and basic cellular networks	3	-	-	3	-	-	-	-	-	-	-	2	-	-	-
CO-2	Analyze different Radio wave propagation models for cellular communication	-	3	-	3	-	-	-	-	-	-	-	-	-	-	3
CO-3	Apply different multipath propagation channel models in wireless systems	-	3	3	-	-	-	-	-	-	-	-	-	-	-	2
CO-4	Illustrate the Link performance improvement techniques	-	3	-	-	-	-	2	-	-	-	-	-	-	-	3
CO-5	Summarize different wireless communication standards and systems	-	-	2	-	-	2	-	-	-	-	-	-	2	-	-

	Part A 10 x 1 = 10marks				
Q.No	**Questions**	**Marks**	**BL**	**CO**	**PO**
1	D	**1**	**1**	**4**	**7**
2	C	**1**	**1**	**4**	**7**
3	B	**1**	**1**	**4**	**2**
4	C	**1**	**1**	**4**	**2**
5	A	**1**	**1**	**4**	**2**
6	C	**1**	**1**	**5**	**6**
7	A	**1**	**1**	**5**	**3**
8	A	**1**	**1**	**5**	**3**
9	B	**1**	**1**	**5**	**6**
10	D	**1**	**1**	**5**	**3**

Part – B1
(2 × 4 = 8 Marks)
Instructions: Answer any TWO Questions.

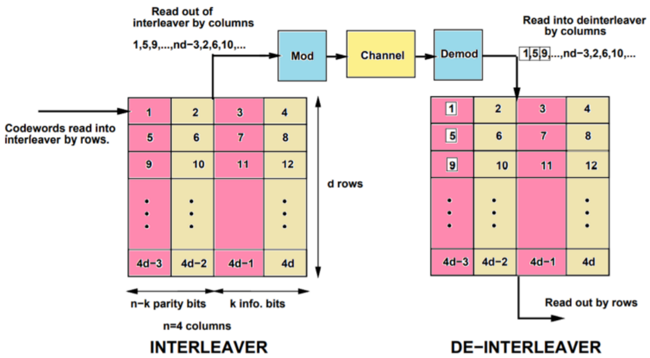
11	Explain the following diversity techniques:	**4**	**2**	**4**	**2**

i) Time diversity **(2 Marks)**

- Time diversity is obtained by re-transmitting the same signal at separate interval of time.
- Time Diversity also does not require any increase in the transmission power.
- Repeatedly transmits information at the time spacing that exceeds the coherence time of the channel.
- The time interval depends on the fading rate, and increases with the decrease in the rate of fading.
- Multiple repetitions of the signals will be received with independent fading conditions, thereby providing diversity.
- Our modern implementation of time diversity involves the use of RAKE receiver for spread spectrum CDMA.
- Coherence Time is the time over which a fading signal can be considered to have similar characteristics)

ii) Interleaving **(2 marks)**

- Used to Obtain time diversity without adding any overhead.
- Used in digital speech coders – wide range of voices in a uniform and efficient digital format.
- Interleaving's only disadvantage is additional latency –receive the entire block of coded bits before they can be put in order and decoded (and then converted into an audio signal, for example). For different applications, latency requirements are different.
- Voice communications are typically the most latency-sensitive, and even cell phone voice data is interleaved.
- The disadvantage is that temporal correlation can be very long for most applications, even for vehicular communications.
- Packet retransmissions (e.g., TCP) can be viewed as time diversity.
- An interleaver is called a deep interleaver, if the condition $dT_s > T_c$ is satisfied.
- The deinterleaver is an array identical to the interleaver.
- Bits are read into the deinterleaver from the demodulator by column so that each row of the deinterleaver contains a codeword (whose bits have been corrupted by the channel.)
- The deinterleaver output is read into the decoder by rows, i.e. one codeword at a time.



12		**4**	**3**	**4**	**2**

- Equalization is a technique used to combat inter symbol interference(ISI).
- An Equalizer within a receiver compensates for the average range of expected channel amplitude and delay characteristics.
- Equalizers must be adaptive as the channel is generally unknown and time varying.
- ISI has been recognized as the major obstacle to high speed data transmission over mobile radio channels.

13	Outage capacity and multiplexing gain	**4**	**1**	**4**	**2**

Outage capacity and multiplexing gain

- The capacity of a communication channel is the maximum, asymptotic (in block length) error-free transmission rate that can be achieved. The capacity of a MIMO channel is a complicated function of the channel conditions and transmit/receive processsing constraints.
- The p percentage outage capacity at SNR ρ, $C_{out,p}(\rho)$, is defined as the transmission rate that can be supported by $(100-p)\%$ of the fading realizations of the channel.
- Hence at SNR, if a frame is transmitted with rate $C_{out,p}(\rho)$, the probability that the frame will be decoded correctly is $(100-p)\%$.

$$P_e(\rho, C_{out,p}(\rho)) = p\%$$

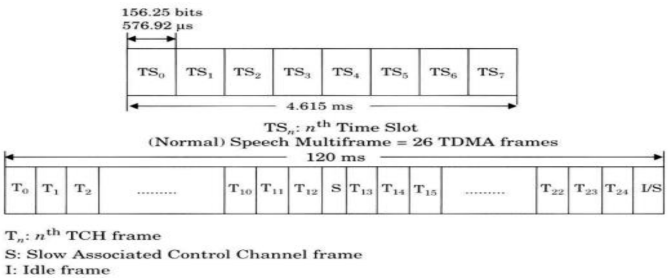
Multiplexing gain

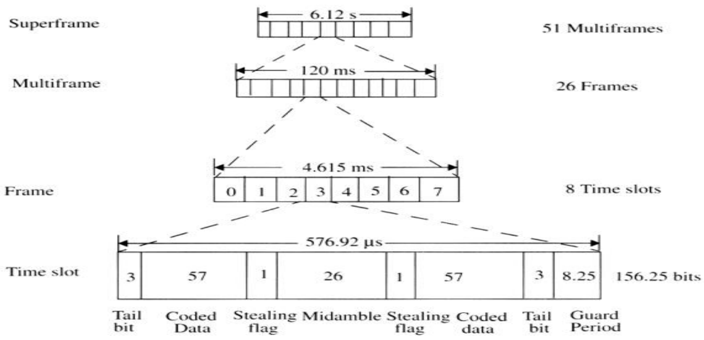
- The maximum multiplexing gain r_{max} that can be achieved over a MIMO channel is given by the asymptotic (in SNR) slope of the outage capacity (for fixed FER) plotted as a function of the SNR on a linear–log scale, i.e.,

$$r_{max} = \lim_{\rho\to\infty} \frac{C_{out,p}(\rho)}{\log_2 \rho}.$$

Part – B1
(2 × 4 = 8 Marks)
Instructions: Answer any TWO Questions.

14		**4**	**3**	**5**	**3**





One multiframe contains 26 TDMA frames, and one superframe contains 51 multiframes, or 1326 TDMA frames.
A hyperframe contains 2048 superframes,

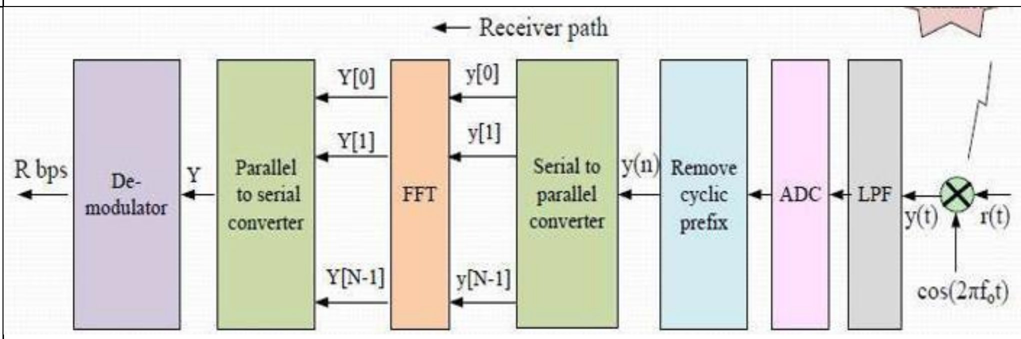
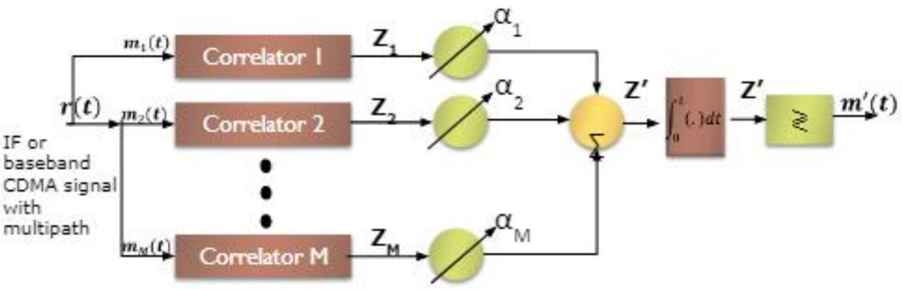
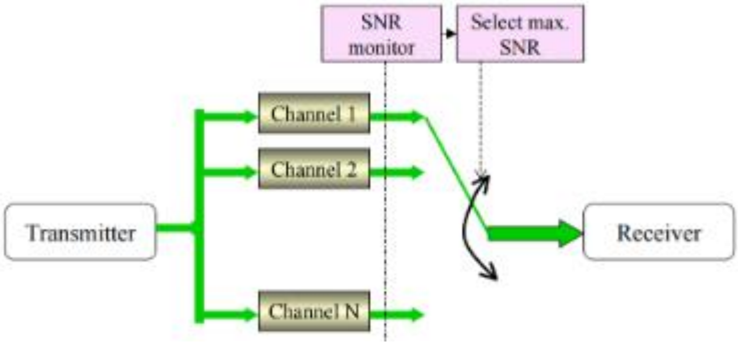
<table>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>15</td><td>

Diagram :3 marks
Explanation 3 marks</td><td>4</td><td>2</td><td>5</td><td>3</td></tr>
<tr><td>16</td><td>CYCLIC PREFIX
• Guard time between adjacent symbols is inserted to eliminate ISI
• No ISI will occurs, if guard time is larger than delay spread
• Guard time is a pure system overhead, contains no information
• CP is inserted in order to preserve orthogonality
• CP provides multipath immunity & synchronization tolerance
• CP increases required transmission bandwidth, hence lowers spectral efficiency
• Transmit power associated with CP is a waste</td><td>4</td><td>1</td><td>5</td><td>6</td></tr>
<tr><td colspan="6">Part – C (2 × 12 = 24 Marks)</td></tr>
<tr><td>17a</td><td>RAKE Receiver
Powerful form of time diversity available in spread spectrum systems → CDMA
Signal is transmitted once only
attempts to collect the time-shifted versions of the original signal by providing a separate correlation receiver for each of the multipath signals.
Each correlation receiver may be adjusted in time delay, so that a microprocessor controller can cause different correlation receivers to search in different time windows for significant multipath.
The range of time delays that a particular correlator can search is called a search window


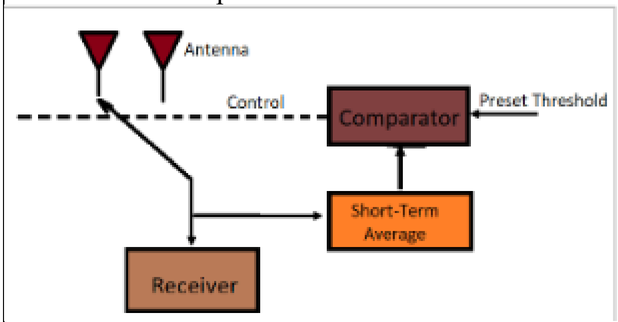
$Z' = \sum_{m=1}^{M} \alpha_m Z_m$ $\alpha_m = \frac{Z_m^2}{\sum_{m=1}^{M} Z_m^2}$</td><td>12</td><td>3</td><td>4</td><td>6</td></tr>
</table>

M branches or “fingers” = # of correlation Rx’s
Separately detect the M strongest signals
Weighted sum computed from M branches
faded signal → low weight
strong signal → high weight
overcomes fading of a signal in a single branch
OR

b i)Selection Combining
Select the Strongest Signal
The receiver branch having the highest instantaneous SNR is connected to the demodulator.



ii) Feedback or Scanning Combining
Scan each antenna until a signal is found that is above predetermined threshold
If signal drops below threshold → rescan
Only one Rx is required (since only receiving one signal at a time), so less costly
→ still need multiple antennas



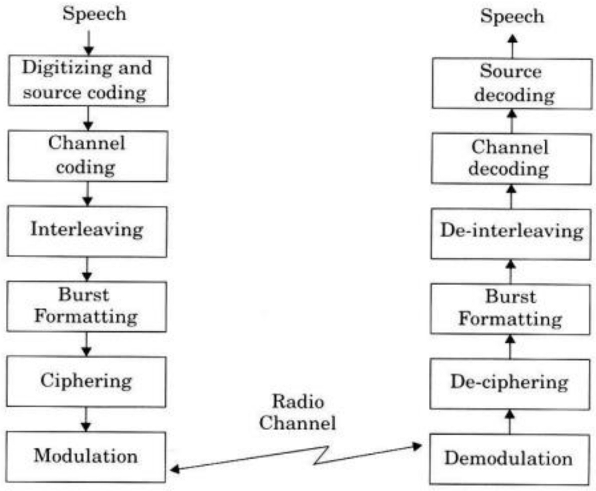
18a	i)	**4**	**3**	**5**	**7**

Solution:
(a) The time duration of a bit, T_b= 1/270.833 kbps= 3.692 μs
(b) The time duration of a slot, T_{slot}= 156.25 x T_b = 0.577 ms.
(c) The time duration of a frame, T_f, = 8 x T_{slot}= 4.615 ms.
(d) A user has to wait 4.615 ms, the arrival time of a new frame, for its next transmission

ii)

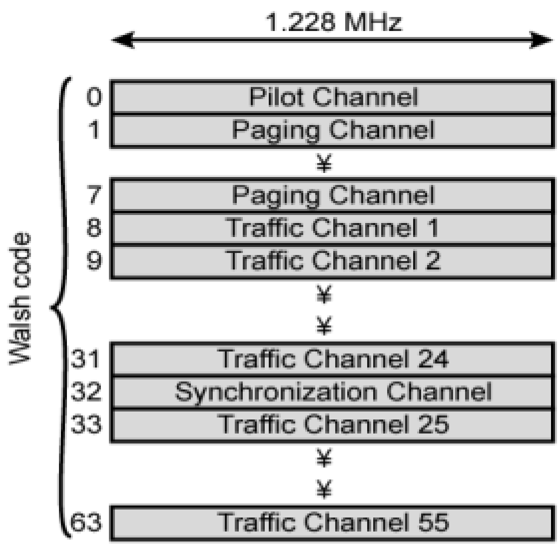
Speech Coding — The GSM speech coder is based on the Residually Excited Linear Predictive Coder (RELP), which is enhanced by including a Long-Term Predictor (LTP) .
The coder provides 260 bits for each 20 ms blocks of speech, which yields a bit rate of 13kbps

8



OR

b **12**

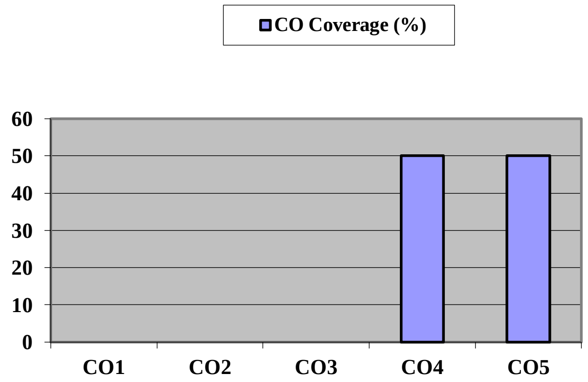


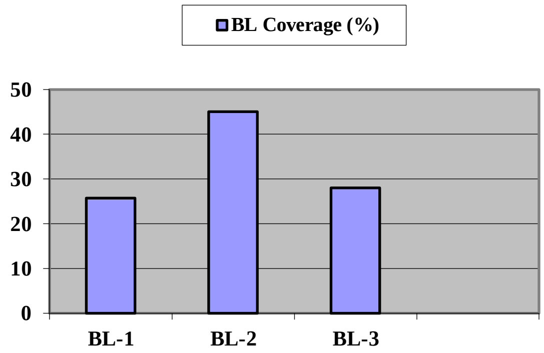
IS -95 Forward channel structure
Up to 64 logical CDMA channels each occupying the same 1228-kHz bandwidth
Four types of channels:
Pilot (channel 0)
Continuous signal on a single channel
allows a mobile station to acquire timing for the Forward CDMA channel
Provides phase reference for demodulation process
provides each mobile with a means for signal strength comparisons between base
stations for determining when to handoff.
Consists of all zeros
Synchronization (channel 32)
1200-bps channel used by mobile station to obtain identification information about the
cellular system
provides each mobile with a means for signal strength comparisons base stations for
determining when to handoff.
Paging (channels 1 to 7)
Contain messages for one or more mobile stations

Traffic (channels 8 to 31 and 33 to 63)

	55 traffic channels Original specification supported data rates of up to 9600 bps Revision added rates up to 14,400 bps				

Course Outcome (CO) and Bloom's level (BL) Coverage in Questions





Approved by the Course Coordinator

Signature of the Question paper sette