**SRM Institute of Science and Technology**

**College of Engineering and Technology**

**DEPARTMENT OF ECE**

SRM Nagar, Kattankulathur – 603203, Chengalpattu District, TamilNadu

**Academic Year: 2024-2025 (ODD)**

**Test: CLAT- 3 Date:16.07.2024**

**Course Code & Title: 18ECC301T Wireless Communication Duration: 8.00-9.40 am**

**Year & Sem: IV& VII Max. Marks: 50**

**Course Articulation Matrix:**

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| **18ECC301T\_Wireless Communication** | **PROGRAM OUTCOMES** | | | | | | | | | | | | **PROGRAM STUDENT OUTCOMES** | | |
| **COURSE OUTCOMES** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **1** | **2** | **3** |
| Interpret the concepts of Wireless communication and basic cellular networks | 3 | - | - | 3 | - | - | - | - | - | - | - | 2 | - | - | - |
| Analyze different Radio wave propagation models for cellular communication | - | 3 | - | 3 | - | - | - | - | - | - | - | - | - | - | 3 |
| Apply different multipath propagation channel models in wireless systems | - | 3 | 3 | - | - | - | - | - | - | - | - | - | - | - | 2 |
| Illustrate the Link performance improvement techniques | - | 3 | - | - | - | - | 2 | - | - | - | - | - | - | - | 3 |
| Summarize different wireless communication standards and systems | - | - | 2 | - | - | 2 | - | - | - | - | - | - | 2 | - | - |

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| **Q. No** | **Answer all the questions** | **Marks** |
|  | d) 24.52 kbps | 1 |
|  | c) 5.74 bps/Hz | 1 |
|  | a) -7 dB | 1 |
| 4. | c) Sum of individual SNRs | 1 |
| 5. | b) Channel state information known at the transmitter | 1 |
| 6. | c) 1/3 | 1 |
| 7. | b) high PAPR | 1 |
| 8. | a) 51 | 1 |
| 9. | d)2048 | 1 |
| 10. | b)1.25 MHz | 1 |
| Part B1 (2×4=8 Marks) | | |
| 11. | Given data:  for .  , , =1 W  To find: Capacity for distance of 100 m.  Solution: - 1 mark, SNR - 2 marks, Capacity - 2 marks | 4 |
| 12. | **Outage capacity: (2 Marks)**   * 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, Cout, P(ρ), 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 Cout,p (ρ), the probability that the frame will be decoded correctly is (100−p)%.     **Multiplexing gain: (2 Marks)**  The maximum multiplexing gain rmax 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. | 4 |
| 13. | **Need of an equalizer:**   * 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. * Intersymbol Interference (ISI) is caused by multipath results in signal distortion occurs in time dispersive, frequency selective fading (bandlimited) channels * Equalization is a method of overcoming ISI broadly refers to any signal processing that minimizes ISI. * Adaptive equalizers can cancel interference & provide diversity. The mobile fading channel is random & time varying, and adaptive equalizers track time varying channel characteristics. | 4 |
| Part B2 (2×4=8 Marks) | | |
| 14. | **Block diagram GSM operations with speech input to speech output**.  F11_11 | 4 |
| 15. | **Forward link channels in CDMA IS -95: each channel – 1 mark**   1. Pilot (channel 0)  * Continuous signal on a single channel * Allows mobile unit to acquire timing information * Provides phase reference for demodulation process * Provides signal strength comparison for handoff determination * Consists of all zeros  1. Synchronization (channel 32)  * 1200-bps channel used by mobile station to obtain identification information about the cellular system * System time, long code state, protocol revision, etc.  1. Paging (channels 1 to 7)  * Contain messages for one or more mobile stations  1. 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 * All channels use same bandwidth * Chipping code distinguishes among channels * Chipping codes are the 64 orthogonal 64-bit codes derived from 64 × 64 Walsh matrix | 4 |
| 16. | **Importance of Cyclic Prefix in OFDM system**   * 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 | 4 |
| Part C (2×4=8 Marks) | | |
| 17a. | **RAKE receiver in CDMA system.**  **Block diagram (6 marks)**    **Explanation (6 marks)**    where,   * 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. * If time delay between multiple signals > chip period of spreading sequence (Tc) → multipath signals can be considered uncorrelated (independent) * In a basic system, these delayed signals only appear as noise, since they are delayed by more than a chip duration and ignored. * Multiplying by the chip code results in noise because of the time shift. * But this can also be used to our advantage, by shifting the chip sequence to receive that delayed signal separately from the other signals. * 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 | 12 |
| 17b. | i) **Selection combining (6 marks)**  Select the Strongest Signal, The receiver branch having the highest instantaneous SNR is connected to the demodulator.      In selection combining (SC), the combiner outputs the signal on the branch with the highest SNR. Since only one branch is used at a time, SC often requires just one receiver that is switched into the active antenna branch. However, a dedicated receiver on each antenna branch may be needed for systems that transmit continuously in order to simultaneously and continuously monitor SNR on each branch.  ii) **Maximal Ratio Combining (6 marks)**  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. | 12 |
| 18a. | **GSM Architecture : (6 Marks)**  F11_5   * Mobile Switching Center (MSC), Base Transceiver Stations (BTS) * Base Station Controllers (BSC) 🡺 controls 100s of BTSs.   + BTS co-located or remotely distributed and physically connected to the BSC by microwave link or dedicated leased lines.   + BSC takes care of handover, reduces load at MSC. * 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) * **Home Location Register:** Contains subscriber information and location information for each user who resides in the **same city as the MSC**. * International Mobile Subscriber Identity (IMSI) is used to identify the home user. * **Visiting Location Register:** Temporarily stores the IMSI and customer information for each roaming subscriber who is visiting the coverage area of a particular MSC. * If a roaming mobile is logged in the VLR:   + The MSC sends the necessary information to the visiting subscriber's HLR.   + So that calls to the roaming mobile can be appropriately routed over the PSTN by the roaming user's HLR. * **Authentication Center:** A strongly protected database which handles the authentication and encryption keys for every single subscriber in the HLR and VLR. * AUC has Equipment Identity Register (EIR). * EIR indentifies stolen or fraudulently altered phones whose identities are not there in VLR or HLR. * **Operation Support Subsystem:** Supports one or several Operation Maintenance Centers (OMC). * **OMC used to monitor and maintain the performance** of each MS, BS, BSC, and MSC within a GSM system. * 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: (3 marks)**  F11_6   * **Abis Interface:** Connects a BTS to BSC, carries traffic and maintenance data. Specified by GSM. * **A Interface:** Interface between a BSC and a MSC, dedicated leased lines or microwave link. * **SS7:** Network message communication between the MSC, the BSS and MSs.   **GSM Frame structure: (3 marks)**  F11_10 | 12 |
| 18b. | **OFDM transmitter and receiver blocks.**  **Diagram (6 marks)**  **Explanation (6 marks)**   * Typically PSK or QAM modulations schemes are used. IFFT performs the transformation efficiently and ensures orthogonality of the sub carriers * Output of IFFT is      * Number of computations are significantly reduced by IFFT. IFFT needs that the number of sub-carriers be an integer to the power of *2* * Unused sub-carriers are set to zero. Complexity of OFDM system is largely determined by IFFT points. More IFFT points demands more power, but enhances resolution | 12 |