COURSE TITLE: WIRELESS COMMUNICATION & NETWORKS
FINAL TERM EXAMINATION
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STUDENT NAME: TAHIR MANSOOR
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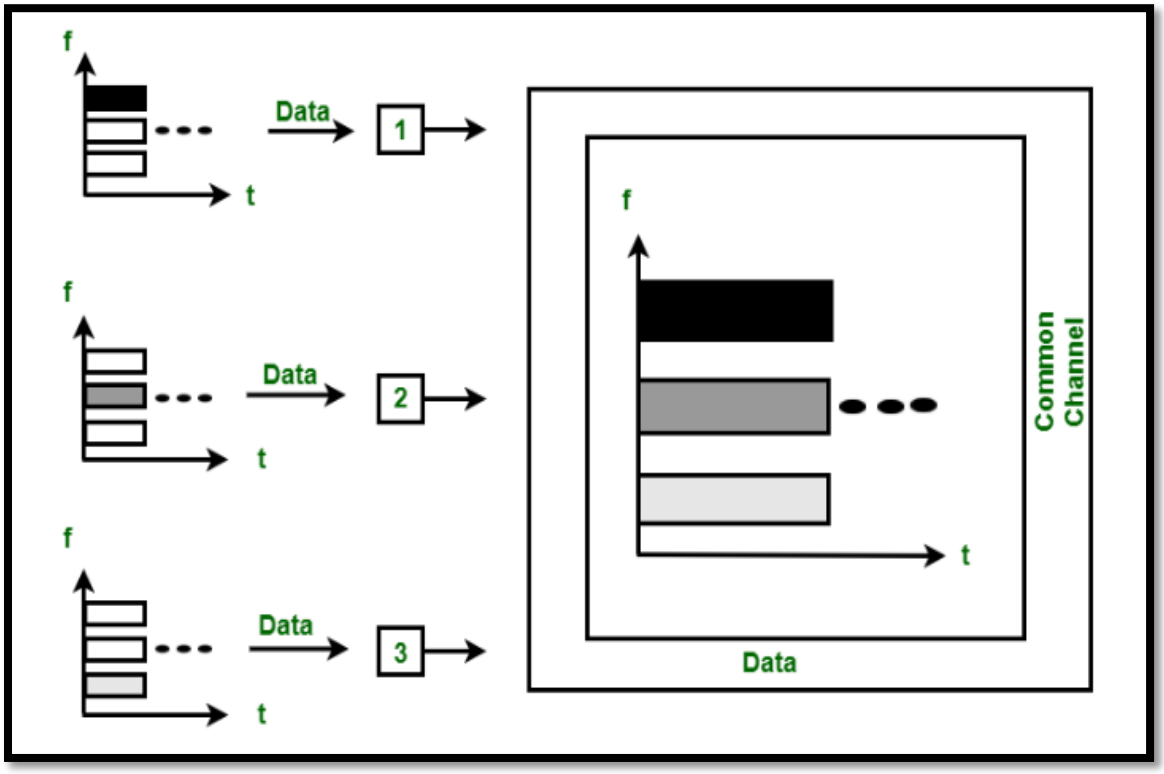
Instructor Name: Dureshahwar Adnan

Question 1. What is TDMA FDMA and CDMA. How CDMA works with diagram?

1. Frequency Division Multiple Access (FDMA) :

FDMA is a type of channelization protocol. In this bandwidth is divided into various frequency bands. Each station is allocated with band to send data and that band is reserved for particular station for all the time which is as follows :



T he frequency bands of different stations are separated by small band of unused frequency and that unused frequency bands are called as guard bands that prevents the interference of stations. It is like access method in data link layer in which data link layer at each station tells its physical layer to make a band pass signal from the data passed to it. The signal is created in the allocated band and there is no physical multiplexer at the physical layer.

2. Time Division Multiple Access (TDMA) :

TDMA is the channelization protocol in which bandwidth of channel is divided into various stations on the time basis. There is a time slot given to each station, the station can transmit data during that time slot only which is as follows :

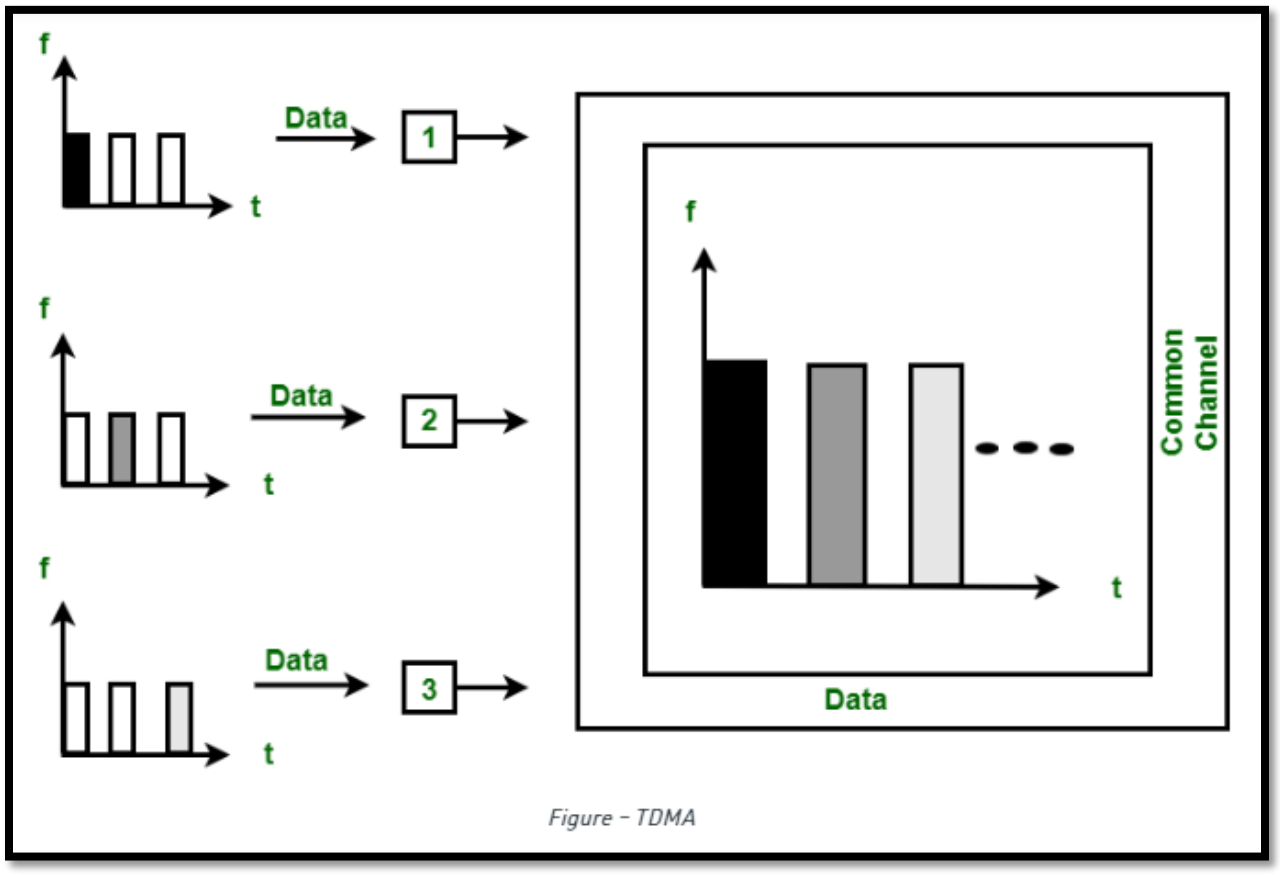


Figure – TDMA

Each station must aware of its beginning of time slot and the location of the time slot. TDMA requires synchronization between different stations. It is type of access method in the data link layer. At each station data link layer tells the station to use the allocated time slot.

3. Code Division Multiple Access (CDMA) :

In CDMA, all the stations can transmit data simultaneously. It allows each station to transmit data over the entire frequency all the time. Multiple simultaneous transmissions are separated by unique code sequence. Each user is assigned with a unique code sequence.

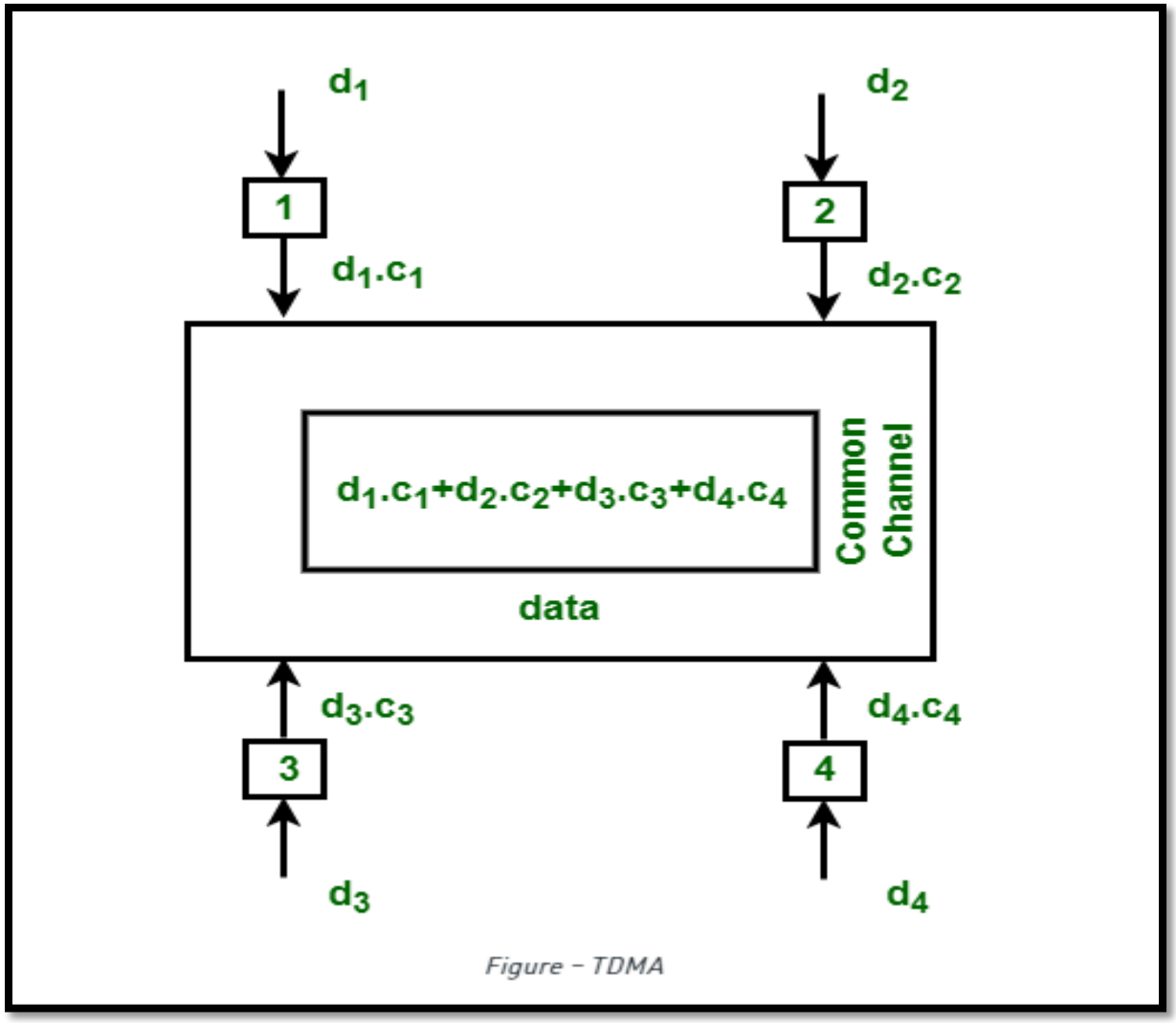


Figure – TDMA

In the above figure, there are 4 stations marked as 1, 2, 3 and 4. Data assigned with respective stations as d_1, d_2, d_3 and d_4 and the code assigned with respective stations as c_1, c_2, c_3 and c_4.

Question 2. What is the difference between fixed and mobile network? What are the 4 major differences between wired and wireless networks?

- **DIFFERENCE BETWEEN MOBILE BROADBAND AND FIXED WIRELESS**

Fixed wireless provides high-speed internet access over a large area, where an internet access point mostly a wireless router beams signal to various devices for connectivity with a radio or other wireless link. Mobile broadband is high-speed internet access delivered over a mobile phone network such as *CDMA, GSM or 3G, 3.5G or 4G LTE*.

Fixed wireless delivers broadband from the backbone of the internet by using base stations to transfer the signal from building to building, like a satellite. Fixed wirless is usually much faster than cellular 4G networks and have low latency, but are limited to densely populated areas because they require line-of-sight connectivity.

- **MAJOR DIFFERENCES BETWEEN WIRED AND WIRELESS NETWORKS**

The following table denotes & explain the difference in both wired and wireless network –

PARAMETER	WIRED	WIRELESS
Communication Medium	Copper, Fiber etc.	Air
Standard	IEEE 802.3	802.11 family
Mobility and Roaming	Limited	Higher
Security	High	Lower than Wired. Also easy to hack

PARAMETER	WIRED	WIRELESS
Speed / Bandwidth	High Speed upto 1 Gbps	Lower speed than Wired Network.
Access to Network	Physical Access Required	Proximity Required
Delay	Low	High
Reliability	High	Lower than Wired
Flexibility to change	Less flexible to changes	More flexible configuration
Working principle	CSMA/CD, operates by detecting the occurrence of a collision.	CSMA/CA , hence reduces possibility of collision be avoiding collision from happening
Interference and Fluctuations vulnerability	Very Less	High
Installation activity	Cumbersome and manpower intensive	Less labor intensive and easy
Installation Time	Takes longer time to perform	Very less deployment time
Dedicated / Shared Connection	Dedicated	Shared

PARAMETER	WIRED	WIRELESS
Installation Cost	High	Low
Maintenance (Upgrade) cost	High	Low
Related equipment	Router, Switch , Hub	Wireless Router, Access Point
Benefits	* Greater Speed * Higher noise immunity * Highly reliable * Greater Security	* No Hassles of Cable * Best for mobile devices * Greater mobility * Easy installation and management

Question 3. How many voice channels are supported for each 30 KHz radio channel in is 136? Which of the following is a 2.5 G CDMA standard?

Interim Standard 136 (IS-136) was popularly known as North American Digital Cellular (NADC) system. It divides each 30 KHz radio channel into three time slots, each of 10 KHz.

The explanation: IS-95B (Interim Standard 95B) is code division multiple access standard for 2.5G. It is an upgradation of IS- 95 which is a second generation standard of CDMA.

Question 4. What do you mean by Error Control coding? What is cyclic error control coding?

ERROR CONTROL CODING

Error control coding is the coding procedure done to control the occurrences of errors. These techniques help in Error Detection and Error Correction.

There are many different error correcting codes depending upon the mathematical principles applied to them. But, historically, these codes have been classified into **Linear block codes** and **Convolution codes**.

- **Linear Block Codes**

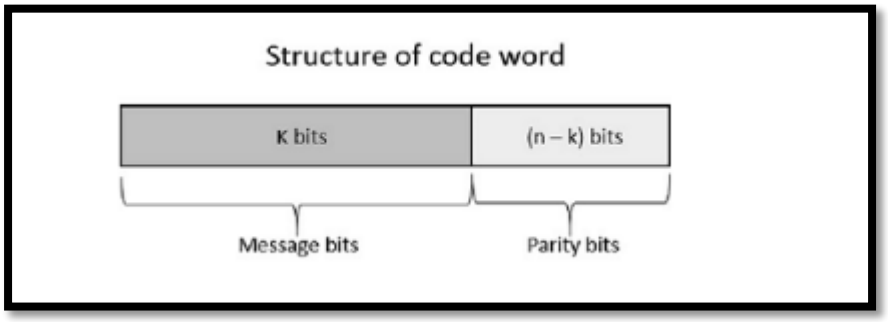
In the linear block codes, the parity bits and message bits have a linear combination, which means that the resultant code word is the linear combination of any two code words.

Let us consider some blocks of data, which contains **k** bits in each block. These bits are mapped with the blocks which has **n** bits in each block. Here **n** is greater than **k**. The transmitter adds redundant bits which are n−kn−k bits. The ratio **k/n** is the **code rate**. It is denoted by **r** and the value of **r** is **r < 1**.
The n−kn−k bits added here, are **parity bits**. Parity bits help in error detection and error correction, and also in locating the data. In the data being transmitted, the left most bits of the code word correspond to the message bits, and the right most bits of the code word correspond to the parity bits.

- **Systematic Code**

Any linear block code can be a systematic code, until it is altered. Hence, an unaltered block code is called as a **systematic code**.

Following is the representation of the **structure of code word**, according to their allocation.



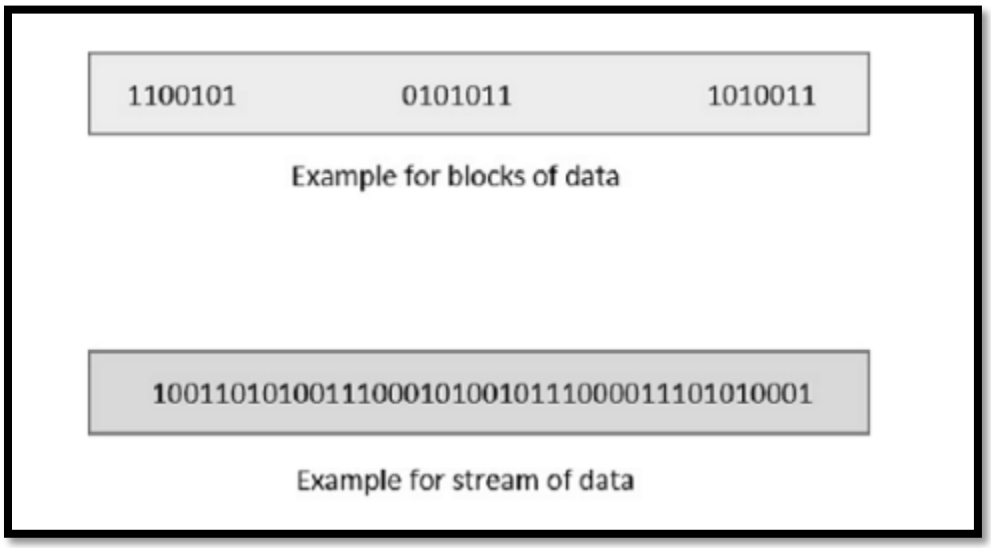
If the message is not altered, then it is called as systematic code. It means, the encryption of the data should not change the data.

- **Convolution Codes**

So far, in the linear codes, we have discussed that systematic unaltered code is preferred. Here, the data of total **n** bits if transmitted, **k** bits are message bits and n−kn−k bits are parity bits.

In the process of encoding, the parity bits are subtracted from the whole data and the message bits are encoded. Now, the parity bits are again added and the whole data is again encoded.

The following figure quotes an example for blocks of data and stream of data, used for transmission of information.



CYCLIC CODES:

In coding theory, cyclic codes are linear block error-correcting codes that have convenient algebraic structures for efficient error detection and correction.

Let C be a linear code over a finite field $GF(q)^n$ of block length n. C is called a cyclic code, if for every codeword $c=(c_1,...,c_n)$ from C, the word $(c_n,c_1,...,c_{n-1})$ in $GF(q)^n$ obtained by a cyclic right shift of components is again a codeword. Same goes for left shifts. One right shift is equal to $n-1$ left shifts and vice versa. Therefore the linear code C is cyclic precisely when it is invariant under all cyclic shifts.

Cyclic Codes have some additional structural constraint on the codes. They are based on Galois fields and because of their structural properties they are very useful for error controls. Their structure is strongly related to Galois fields because of which the encoding and decoding algorithms for cyclic codes are computationally efficient.

CYCLIC CODE FOR CORRECTING ERROR:

a) For correcting single error

The cyclic codes explicitly with error detection and correction. Cyclic codes can be used to correct errors, like Hamming codes as a cyclic codes can be used for correcting single error. Likewise, they are also used to correct double errors and burst errors. All types of error corrections are covered briefly in the further subsections.

The Hamming code has a generator polynomial $g(x)=x^3+x+1$. This polynomial has a zero in Galois extension field GF(8) at the primitive element a, and all codewords satisfy .

C(a)=0 Cyclic codes can also be used to correct double errors over the field GF(2). Blocklength will be n equal to 2^m-1 and primitive elements a and a^3 as zeros in the $GF(2^m)$ because we are considering the case of two errors here, so each will represent one error.The received word is a polynomial of degree n-1 given as

$$v(x) = a(x)g(x) + e(x)$$

where e(x) can have at most two nonzero coefficients corresponding to 2 errors.

Syndrome Polynomial, S(x) as the remainder of polynomial v(x) when divided by the generator polynomial g(x) i.e.

S(x)=v(x) mod g(x)= (a(x)g(x)+e(x)) mod g(x)=e(x) mod g(x) as (a(x)g(x)) mod g(x) is zero

b) For correcting two errors

Let the field elements $X_1$and X_2 be the two error location numbers. If only one error occurs then X_2 is equal to zero and if none occurs both are zero.

Let $S_1 = v(\alpha)$ and $S_3 = v(\alpha^3)$.

These field elements are called "syndromes". Now because $g(x)$is zero at primitive elements $\alpha$and α^3, so we can write $S_1 = e(\alpha)$ and $S_3 = e(\alpha^3)$. If say two errors occur, then

$$S_1 = \alpha^i + \alpha^{i'} \text{ and } S_3 = \alpha^{3i} + \alpha^{3i'}.$$

And these two can be considered as two pair of equations in $GF(2^m)$ with two unknowns and hence we can write

$$S_1 = X_1 + X_2 \text{ and } S_3 = (X_1)^3 + (X_2)^3.$$

Hence if the two pair of nonlinear equations can be solved cyclic codes can used to correct two errors.