Quiz Solutions

Lecture 1,2,3

Quiz-1 - Integer43

Set-1

Qqq1

%1q) What is the problem of using a crossbar switch? [1]

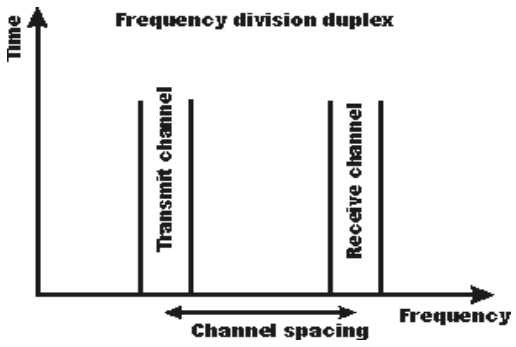
Solution: *By Rezina-102*

The major problem of crossbar switch is the number of crosspoints required. To connect n inputs to m outputs using a cross bar switch requires n x m crosspoints, which is inefficient because statistics show that, in practice, fewer than 25 percent of the crosspoints are in use at any given time.The rest are idle.

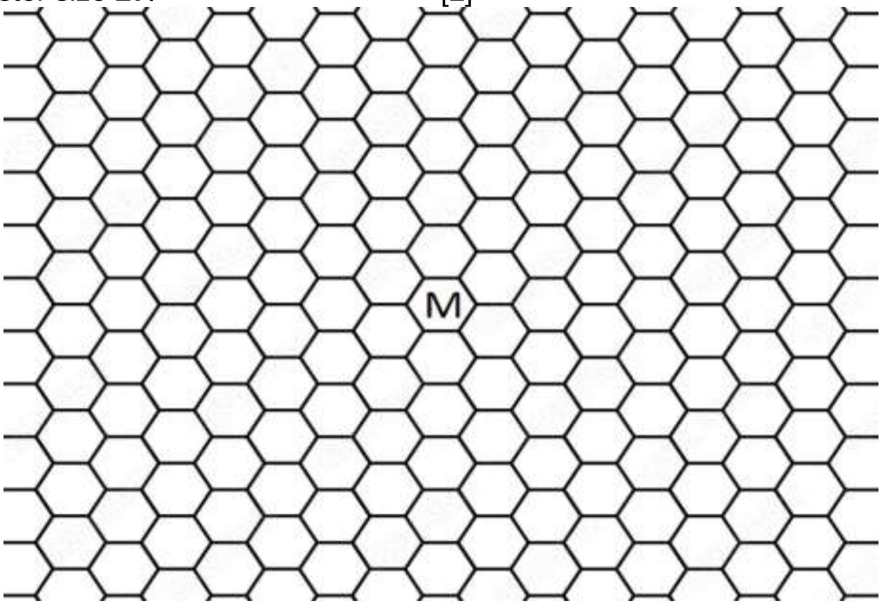
2. a) How does FDD channel work? [1]

Solution: *by Younus-131*

FDD (Frequency Division Duplexing) is a wireless communication method that requires two separate channels for transmitting and receiving data. It is used in microwave (MW) links, millimeter wave (MMW) links, and some 4G/LTE networks. FDD requires two symmetrical segments of spectrum for uplink and downlink channels, which can be costly due to the scarcity and expense of spectrum. However, it is widely used in cellular telephone systems like GSM, and is used in Long-Term Evolution (LTE) 4G cell phone strategies. FDD also works on cables with different transmit and receive channels, using filters to maintain separation.

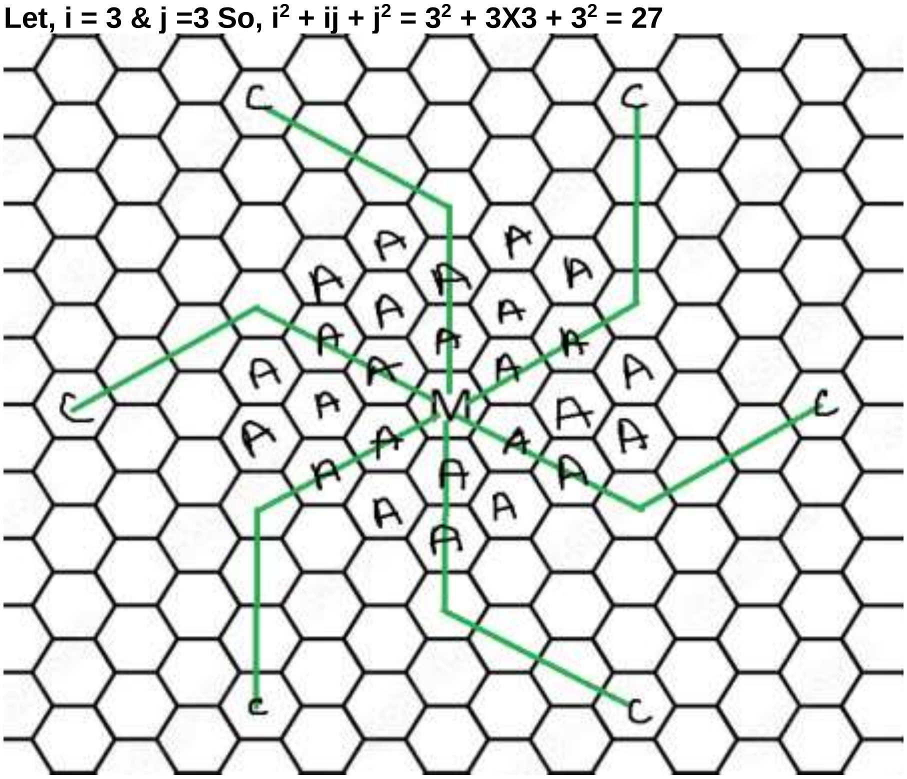


2. b) Find the co channel cells (mark by C) and adjacent cells (mark by A) for the cell M. Assume cluster size **27**. [2]



Solution: ***by Younus-131***

Let, i = 3 & j =3 So, $i^2 + ij + j^2 = 3^2 + 3X3 + 3^2 = 27$



From Lecture 4

3. Assume a geographic area of 212.48 Km² is covered by a cellular system with a cell radius of 1.6 km. A total frequency bandwidth that supports 309 channels, and a reuse factor of N = 9. If there are 0.96 MHz is dedicated to the control channel which uses 10 KHz for simplex channel. [4]

a. How many cells are there in the geographic area?
b. How many traffic channels are there per cell?
c. What is the capacity of the system?
d. How many times the total frequencies are reused?

3.a. Solution: ***by Younus-131***

Each cell area = $\frac{3\sqrt{3}}{2} \times 1.6^2$ = 6.65 Km²

No. of cell = 212.48 Km² / 6.65 Km² = 31.95 ≈ 32

3.b. Solution:

No. of Control Channel = (0.96 X 10^6) / (2 X 10 X 10^3) = 48 *channels*

Traffic Channel = 309 - 48 = 261 *channels*

No. of Traffic Channel per cell = 261 / 9 *[N=9]* = 29 *channels*

3.c. Solution:

Capacity = No. of Channel X No. of Cell = 29 X 32 = 928

3.d. Solution:

Total frequencies are reused = No. of Cell / N = 32 / 9 = 3.556

Set-2

1. a) Consider the following wave form (Fig-1) as bit string of 1s and 0s and frequency components are 1f, 3f, 5f. Find the bandwidth and data rate of the signal. [2]

Solution: ***by Younus-131***

Frequency, f = 1/T = 1 / (0.5 X 10^-6) = 2 X 10^6 Hz

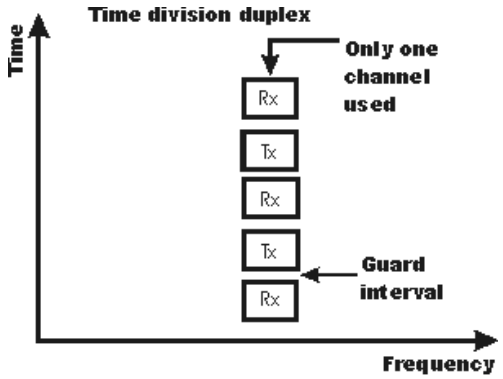
Bandwidth = 5f - 1f = 4f = 8 MHz

Data Rate = 2f = 4 Mbps

1. b) How does TDD channel work? [1]

Solution: ***by Younus-131***

TDD is a wireless system that uses a single frequency band for transmit and receive operations, assigning alternating time slots for transmission and reception. It is used in WiFi networks and some 4G/LTE networks. TDD allows for concurrent transmissions, making it undetectable to the communicating parties. The system can be symmetrical or asymmetrical, depending on the needs of the communication. It requires precise timing and synchronization at both transmitter and receiver to prevent overlap or interference. Guard times are needed between time slots to prevent overlap, which is equal to the send-receive turnaround time and any transmission delays.

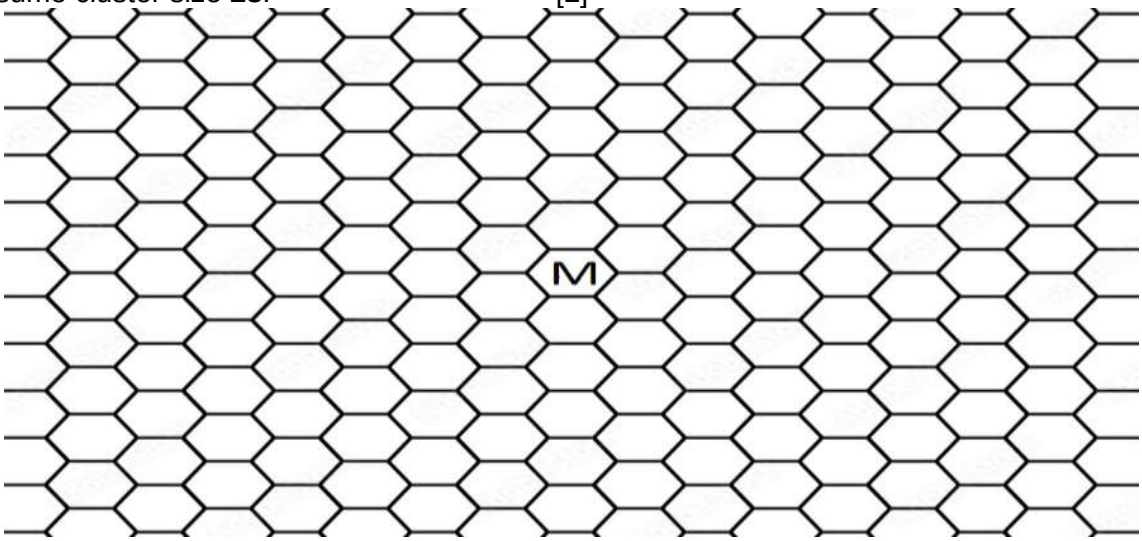


2. a) What is effective BW? [2]

Solution: by Sujon 49

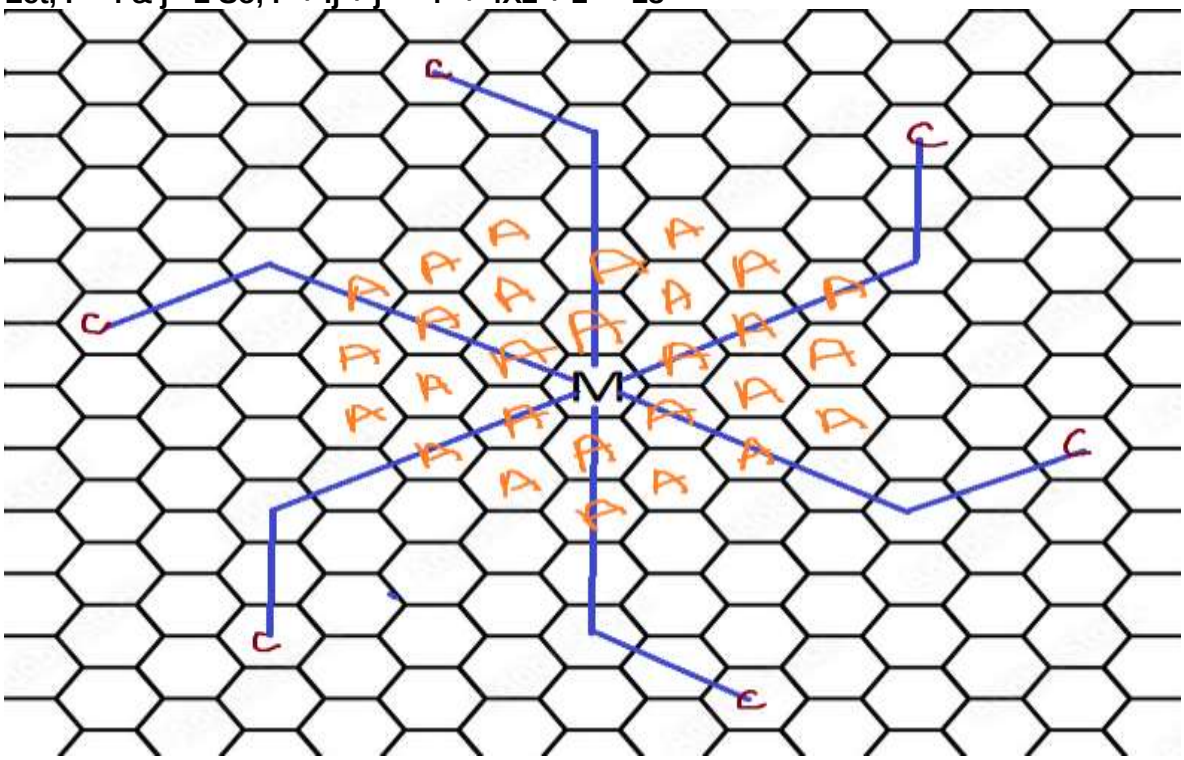
The effective bandwidth (EBW) (bandwidth) of a signal is the width of the spectrum that contains at least 50% of the signal's total power. This is the part of the signal whose power is within 3 dB of the complete signal.

2. b) Find the co channel cells (mark by C) and adjacent cells (mark by A) for the cell M. Assume cluster size **28**. [2]



Solution: ***by Younus-131***

Let, i = 4 & j =2 So, $i^2 + ij + j^2 = 4^2 + 4X2 + 2^2 = 28$



From Lecture 4

3. Assume a FDD cellular system of 40 cells with a cell radius of 1.5 km. A total of 50 MHz of bandwidth is allocated which uses 5 KHz simplex channel. If there are 1000 channels dedicated to control channel and a reuse factor of N = 7. [4]

a. What geographic area is covered by the system?
b. How many traffic channels are there per cell?
c. What is the total number of concurrent calls that can be handled?
d. How many times the total frequencies are reused?

3.a. Solution: ***by Younus-131***

Area = $\frac{3\sqrt{3}}{2} \times 1.5^2 \times 40 = 233.826$ Km^2

3.b. Solution:

Total no. of Channel = (50 X 10^6) / (2 X 5 X 10^3) = 5000 *channels*
Total Traffic Channels = 5000 - 1000 = 4000 *channels*
No. of Traffic Channel per cell = 4000 / 7 *[N=7]* = 571.4286 ≈ 571 *channels*

3.c. Solution:

Total no. of concurrent calls that can be handled = 571 X 40 = 22840 *calls*

3.d. Solution:

Total frequencies are reused = No. of Cell / N = 40 / 7 = 5.714

Set-3

1. a) Consider the following wave form (Fig-1) as bit string of 1s and Os and frequency components are 1f, 3f, 5f, 7f. Find the bandwidth and data rate of the signal. [2]

Fig-1

Solution: ***by Younus-131***

Frequency, f = 1/T = 1 / (0.25 X 10^-6) = 4 X 10^6 Hz
Bandwidth = 7f - 1f = 6f = 24 MHz
Data Rate = 2f = 8 Mbps

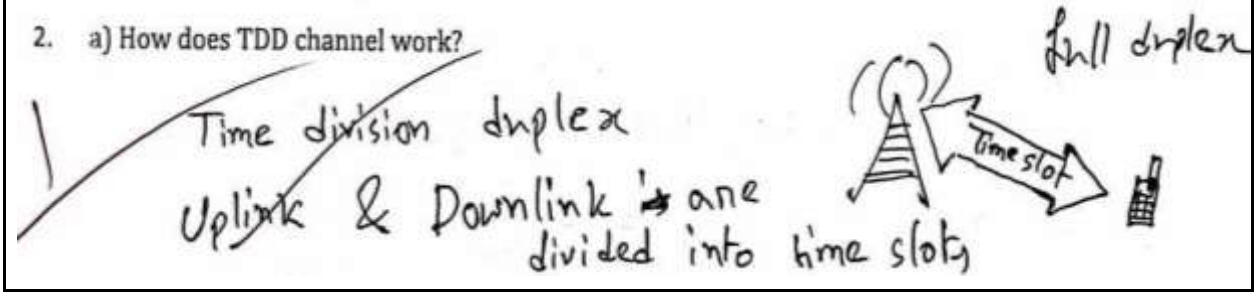
1. b) What is the problem of using a crossbar switch? [1]

Solution: *By Rezina-102*

The major problem of crossbar switch is the number of crosspoints required. To connect n inputs to m outputs using a cross bar switch requires nxm crosspoints, which is inefficient because statistics show that, in practice, fewer than 25 percent of the crosspoints are in use at any given time.The rest are idle.

2. a) How does TDD channel work? [1]

Solution: ***Added from the Answer script by Younus-131***



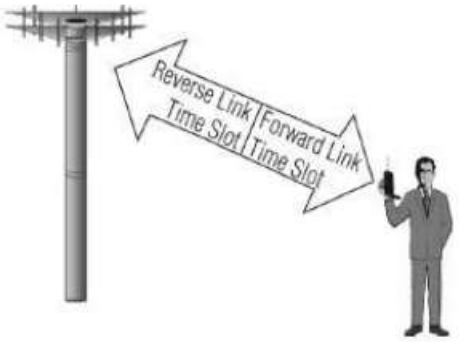
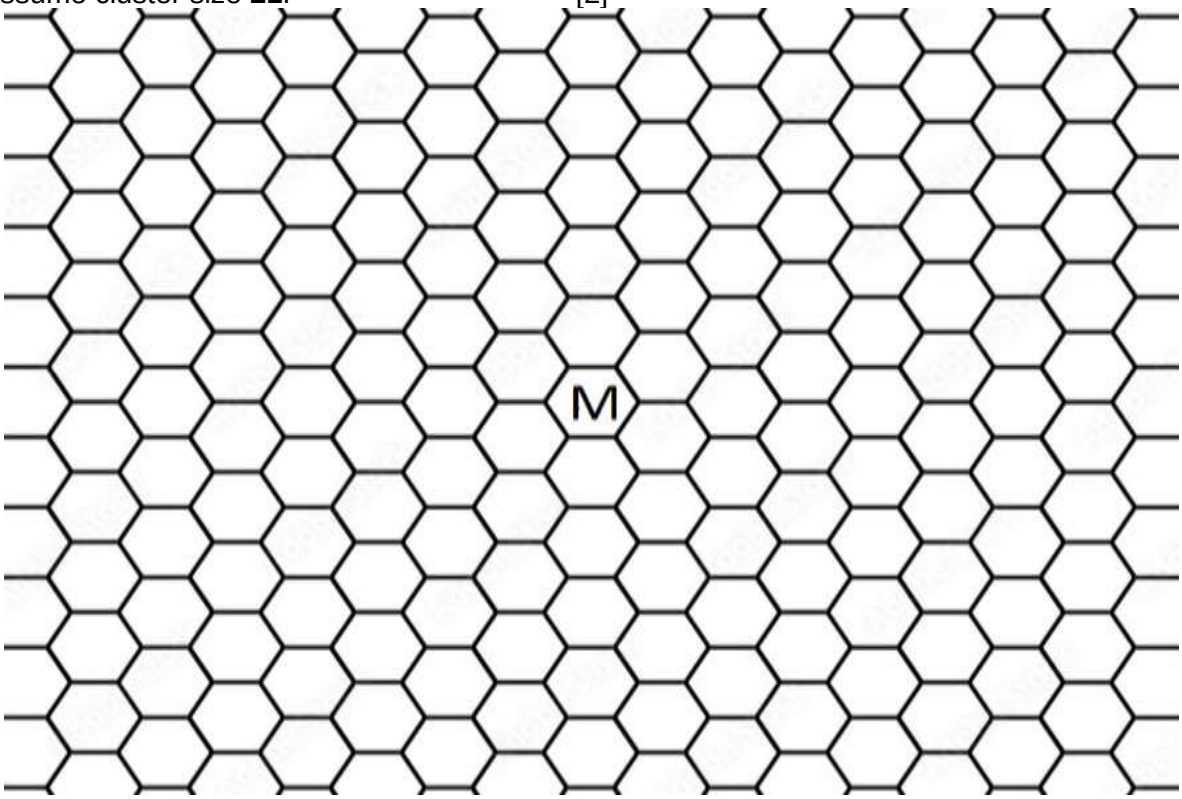


Figure (b) TDD

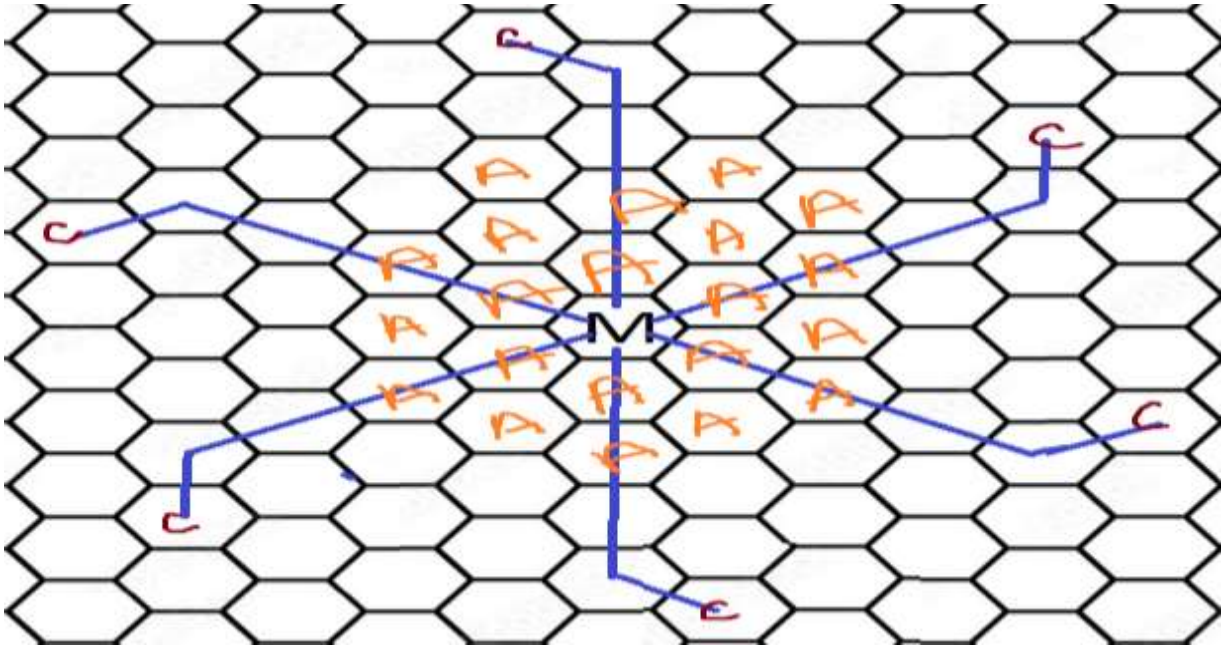
An alternative answer to this question has been added above …

2. b) Find the co channel cells (mark by C) and adjacent cells (mark by A) for the cell M. Assume cluster size **21**. [2]



Solution: ***by Younus-131***

Let, i = 4 & j =1 So, $i^2 + ij + j^2 = 4^2 + 4X1 + 1^2 = 21$



From Lecture 4

3. Assume a FDD cellular system of 35 cells with a cell radius of 1.7 km. A total of 75 MHz of bandwidth is allocated which uses 15 KHz simplex channel. If there are 88 channel is dedicated to control channel and a reuse factor of N = 9. [4]

a. What geographic area is covered by the system?
b. How many traffic channels are there per cell?
c. What is the total number of concurrent calls that can be handled?
d. How many times the total frequencies are reused?

3.a. Solution: ***by Sujon-49***

Area = $\frac{3\sqrt{3}}{2} \times 1.7^2 \times 35 = 262.795$ Km^2

3.b. Solution:

Total no. of Channel = (75 X 10^6) / (2 X 15 X 10^3) = 2500 *channels*
Total Traffic Channels = 2500 - 88 = 2412 *channels*
No. of Traffic Channel per cell = 2412 / 9 *[N=9]* = 268 *channels*

3.c. Solution:

Total no. of concurrent calls that can be handled = 268 X 35 = 9380 *calls*

3.d. Solution:

Total frequencies are reused = No. of Cell / N = 35 / 9 = 3.88

Set-4

1. a) A path in a digital circuit-switched network has a data rate of 1 Mbps. The queuing delay and processing delay is 3 ms. The distance between two parties is 5000 km and the propagation speed is 2 * 10 ^ 8 m. What is the latency if 1000 bits of data are exchanged during the data transfer phase? [2]

Solution: ***by Younus-131***

Propagation time = $\frac{d}{S} = \frac{5000X10^3}{2X10^8}$ = 25X10^-3 s = 25 ms

Transmission time = $\frac{size\ of\ the\ message}{data\ Rate} = \frac{1000}{1X10^6}$ = 1X10^-3 s = 1 ms

So, Latency = Propagation delay + Transmission delay + Queuing delay + Processing delay

= (25 + 1 + 3 + 3) ms = 32 ms [Ans.]

1. b) What is absolute BW? [1]

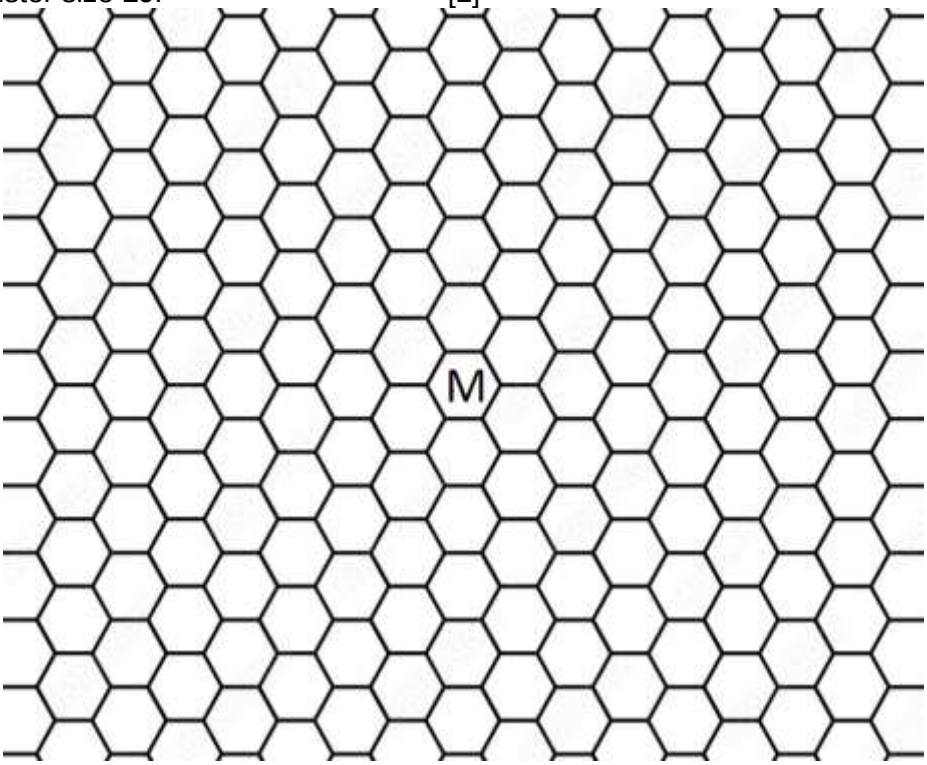
Solution: ***by Younus-131***

Absolute bandwidth is the width of the spectrum (e.g. the largest frequency component minus the smallest frequency component).

2. a) How does the FDD channel work? [1]

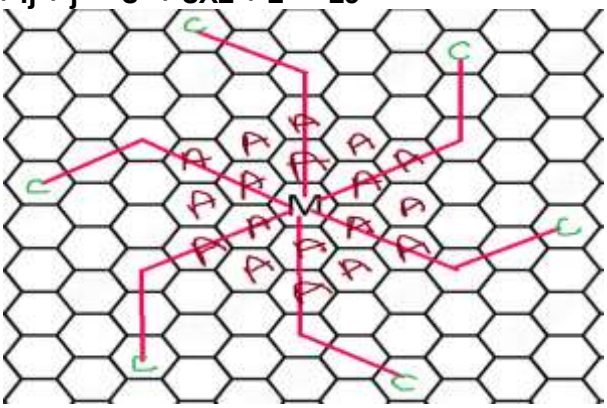
Solution: ***already added above …***

2. b) Find the co channel cells (mark by C) and adjacent cells (mark by A) for the cell M. Assume cluster size **19**. [2]



Solution: ***by Younus-131***

Let, i = 3 & j = 2 So, $i^2 + ij + j^2 = 3^2 + 3X2 + 2^2 = 19$



From Lecture 4

3. Assume a geographic area of 371.84 Km^2 is covered by a cellular system with a cell radius of 1.6 km. A total frequency bandwidth that supports 400 channels, and a reuse factor of N=7. If there are 1.5 MHz is dedicated to the control channel which uses 15 KHz for simplex channel. [4]

a. How many cells are there in the geographic area?
b. How many traffic channels are there per cell?
c. What is the total number of concurrent calls that can be handled?
d. How many times the total frequencies are reused?

3.a. Solution: ***by Younus-131***

Area = $\frac{3\sqrt{3}}{2} \times 1.6^2 = 6.65\ Km^2$

No. of cell = 371.84 Km^2 / 6.65 Km^2 = 56

3.b. Solution:

No. of Control Channel = (1.5 X 10^6) / (30 X 10^3) = 50 *channels*
Traffic Channel = 400 - 50 = 350 *channels*
No. of Traffic Channel per cell = 350 / 7 *[N=7]* = 50 *channels*

3.c. Solution:

Capacity = No. of Channel X No. of Cell = 50 X 56 = 2800

3.d. Solution:

Total frequencies are reused = No. of Cell / N = 56 / 7 = 8

Quiz-1 - Previous Semester

Set-A

1. Why is ADSL unsuitable for business? How do we get 1.44 Mbps upstream data rate for ADSL Modem? [1.5]

   Ans: The designers of ADSL specifically divided the available bandwidth of the local loop unevenly for the residential customer. The service is not suitable for business customers who need a large bandwidth in both directions.

   There are 24 channels, each using 4 kHz (out of 4.312 kHz available) with QAM modulation, we have 24 x 4000 x 15, or a 1.44-Mbps bandwidth, in the upstream direction.

2. A path in a digital circuit-switched network has a data rate of 1 Mbps. The queuing delay and processing delay is 3 ms. The distance between two parties is 5000 km and the propagation speed is 2 X 10^8 m. What is the latency if 1000 bits of data are exchanged during the data transfer phase? [2]

   Ans:
   Transmission delay = L/R = 1000 bits/ $1x10^6$ = 1 ms
   Propagation delay = D/S = 5000x 10^3/ $2x10^8$ = 25 ms
   Latency = Transmission delay + Propagation delay + Queuing delay + Processing delay
   = 1 ms + 25 ms + 3 ms + 3 ms = 32 ms.

3. Consider the following wave form (Fig-1) as bit string of 1s and 0s and frequency components are 1f, 3f, 5f. Find the bandwidth and data rate of the signal. [1.5]

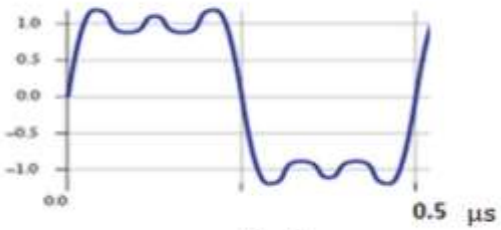


Fig-1

Ans:
BW = 5f – 1f = 4f Hz
Data rate = 2f bps
Here, T = 0.5 micro sec.
f = 1/T = 2 MHz
BW = 4x2 = 8 MHz
Data Rate = 2x2 = 4 Mbps

From Lecture 4

4. Assume a geographic area of 213 Km^2 is covered by a cellular system with a cell radius of 1.6 km. A total frequency bandwidth that supports 336 channels, and a reuse factor of N = 9. If there are 1 MHz is dedicated to control channel which uses 10 KHz for simplex channel. [5]

a. How many cells are there in the geographic area? [1.5]

Area of Hexagon = 1.5 x R^2 x sqrt(3) = 1.5 x 1.6^2 x sqrt(3) = 6.64 Km^2
Total no. of cells = 213 km^2/ 6.64 km^2 = 32

b. How many traffic channels are there per cell? [1.5]

No. of control ch = 1 MHz / 20 KHz = 50
No. of Traffic Ch = 336-50 = 286
N = 9, No. of Traffic ch/ cell = 286/9 = 32

c. What is the capacity of the system? [1]

Total capacity of the system = no. of ch/ cell x no. of cell
= 32 x 32 = 1024

d. How many times the total frequencies are reused? [1]

No. of reused = no. of cell / N = 32/9 = 4

5. a. How is blocking related to crossbar switch?
Solution: 039

- Blocking
  - Blocking refers to times when one input cannot be connected to an output because there is no path available between them-all the possible intermediate switches are occupied.
  - In a single-stage switch, blocking does not occur because every combination of input and output has its own crosspoint; there is always a path.

5. b. What is the Local loop?
Solution: 039
In a telephone system, the local loop is a two-wire connection between the subscriber's house and the end office of the telephone company.
https://www.tutorialspoint.com/the-local-loop

5. c. What is the function of POP?
Solution: 039
A point of presence (POP) is a switching office within a LATA. Each IXC that wants to provide inter-LATA services in a LATA must have a POP in that LATA.

5. d. What is the FDD channel?
Solution: ***already added above …***

5. e. What is problem of Fixed channel assignment technique?
Solution: 039
If all the channels in that cell are occupied, the call is blocked and the subscriber does not receive service.

Set-B

1. Why is ADSL unsuitable for business? How do we get 13.4 Mbps downstream data rate for ADSL Modem? [1.5]

Ans: : The designers of ADSL specifically divided the available bandwidth of the local loop unevenly for the residential customer. The service is not suitable for business customers who need a large bandwidth in both directions.

There are 224 channels, each using 4 kHz (out of 4.312 kHz available) with QAM modulation, we can achieve up to 224 x 4000 x 15, or 13.4 Mbps in the downstream direction.

2. The digital signal is to be designed to permit 160 kbps for a bandwidth of 20 KHz. [2] Determine (a) Number of levels and (b) S/N ratio.

a) $C = 2B\log_2 M$, $160\text{ k} = 2 \times 20\text{k} \times \log_2 M$, $4 = \log_2 M$, $M = 2^4 = 16$.
b) $C = B\log_2(1+SNR)$, $160\text{k} = 20\text{k}\log_2(1+SNR)$, $8 = \log_2(1+SNR)$, $SNR = 2^8 - 1 = 255$.

3. Consider the following wave form (Fig-1) as bit string of 1s and 0s and frequency components are 1f, 3f, 5f, 7f. Find the bandwidth and data rate of the signal. [1.5]

Fig-1

Ans:
BW = 7f – 1f = 6f Hz
Data rate = 2f bps
Here, T = 0.25 micro sec.
f = 1/T = 4 MHz
BW = 6x4 = 24 MHz
Data Rate = 2x4 = 8 Mbps/ 8x4 = 32Mbps

From Lecture 4

4. Assume a FDD cellular system of 40 cells with a cell radius of 1.5 km. A total of 50 MHz of bandwidth is allocated which uses 5 KHz simplex channel. If there are 1000 channel is dedicated to control channel and a reuse factor of N = 7. [5]

a. What geographic area is covered by the system?

Area of Hexagon = $1.5 \times R^2 \times \text{sqrt}(3) = 1.5 \times 1.5^2 \times \text{sqrt}(3) = 5.7\ Km^2$
Total area covered = Area x no. of cell = $5.7 \times 40 = 228\ Km^2$

b. How many traffic channels are there per cell?

Total no. of ch = total BW/ BW of simplex ch = 50 MHz/ 10 KHz = 5000
Total traffic ch = 5000-1000 = 4000
N= 7, no. of traffic ch/ cell = 4000/7 = 571

c. What is the total number of concurrent calls that can be handled?

Total no. of concurrent calls = no. of ch/cell x no. of cell = 571 x 40 = 22840

d. How many times the total frequencies are reused?

No. of times reused = no. of cell/N = 40/7 = 6

5. a. How is blocking related to a multistage switch?
Solution:
Blocking in the context of a multistage switch refers to a situation where incoming data cannot be forwarded due to insufficient available pathways or ports. It's like a traffic jam where not all cars can move because the road is blocked. In multistage switches, blocking can occur when there aren't enough open routes to connect input and output ports, causing data to be dropped or delayed. Effective design and routing algorithms aim to minimize blocking in multistage switches to ensure smooth data transmission.
~chatGPT

5. b. What is Trunking?
Solution:
Trunking is the concept that allows a large no of users to share a relatively small number of channels in a cell.

5. c. What is the function of IXC?
Solution:

5. d. What is TDD channel?
Solution: ***already added above …***

5. e. What is the problem of Dynamic Channel Assignment?
Solution:
The problem with Dynamic Channel Assignment (DCA) in wireless networks is that it can be complex, may not completely eliminate interference, and requires real-time adjustments. Coordinating DCA in crowded spectrum environments is challenging, and there are security concerns. Implementing DCA can also be costly and may impact Quality of Service (QoS). Despite these challenges, DCA is essential for efficient spectrum use.
~chatGPT.

Set-1

1. A digital signaling system is required to operate at 9600 bps. If a signal element encodes a 4- bit word, what is the minimum required bandwidth of the channel? [1]
Solution: *added by Younus-131*

Using Nyquist's equation $C=2B\log_2 M$

$$9600=2B\times \log_2 4$$

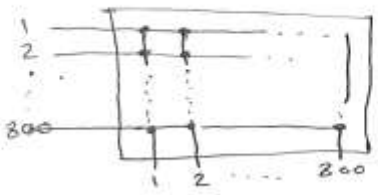
$$\Rightarrow B = 2400\ Hz$$

2. We need to have a space-division switch with 800 inputs and outputs. What is the total number of crosspoints in each of the following cases?
a. Using one single crossbar. [1]
b. Using a multi-stage switch based on the Clos criteria. [2]

Solution: by Rabab 039 (correct if necessary)

Quiz-1 Origin Set-1

2. (a)



No. of crosspoints = $800 \times 800 = 640000$

(b) Using Clos criterion, $n = \sqrt{N/2} = 20$

$k = 2n - 1 = 39$

No. of crosspoints $= N/n(n+k) + k(N/n \times N/n) + N/n(n+k)$

$= 2kN + k(N/n)^2$

$= 2 \times 39 \times 800 + 39 \times 40^2$

$= 124,800$

3. What is the minimum signal-to-noise ratio, in decibels, that must be maintained in order to transmit a 600Kbps signal over a medium with a bandwidth of 20,000Hz? [1]

Solution: ***by Younus-131***

$C = B \log_2 (1 + SNR)$

$\Rightarrow C/B = \log_2 (1 + SNR)$

$\Rightarrow 2^{C/B} = (1 + SNR)$

$\Rightarrow SNR = 2^{C/B} - 1$

$= 2^{600X10\text{^}3 / 20000} - 1 = 1073741823$

$SNR_{db} = 10 \log_{10} (SNR) = 10 \log_{10} (1073741823) = 90.309$ db

4. What are the propagation time and the transmission time for a 2.5-kbyte message if bandwidth of the network is 1 Gbps? Assume that the distance between the sender and the receiver is 12,000 km and that light travels at 2.4 X 10^8 m/s. [3]

Solution: ***by Younus-131***

Given,
$d = 12000$ Km $= 12 \times 10^6$ m
$s = 2.4 \times 10^8$ m/s

Propagation time $= \frac{d}{s} = \frac{12 \times 10^6}{2.4 \times 10^8} = 5.357 \times 10^{-3}$ s $= 5357$ μs

Here,
Size of the message $= 2.5$ Kbyte $= 2.5 \times 10^3$ byte $= 2.5 \times 10^3 \times 8$ bit

band width $= 1$ Gbps $= 1 \times 10^9$ bps

Transmission time $= \frac{\text{size of the message}}{\text{band width}} = \frac{2.5 \times 10^3 \times 8}{1 \times 10^9}$ s $= 2 \times 10^{-5}$ s $= 20$ μs

5. Consider the following waveform as a bit string of 1s and 0s and frequency components are 1f, 3f, 5f, 7f. Find the bandwidth and data rate of the signal. [2]

Solution:
Ekhane time er unit dewa nai, jodi time er unit ***microsecond*** hoy taholee solution nicher ta …

by Younus-131

Frequency, f = 1/T = 1 / (0.5 X 10^-6) = 2 X 10^6 Hz = 2 MHz
Bandwidth = 7f - 1f = 6f = 12 MHz
Data Rate = 2f = 4 Mbps

Set-2

1. What is the maximum capacity of a medium with a bandwidth of 750 KHz and a signal-to-noise ratio of 30 dB? [1]

Solution: ***by Younus-131***

SNR = $10^{\frac{SNR_{db}}{10}} = 10^{\frac{30}{10}} = 1000$

C = B $\log_2$ (1 + SNR) = 750 $\log_2$ (1 + 1000) = 7475.4197 kbps

2. What are the propagation time and the transmission time for a 3-kbyte message if the bandwidth of the network is 10 Mbps? Assume that the distance between the sender and the receiver is 36000 Km and that light travels at 2.4 X 10^8 m/s. [3]

Solution: ***by Younus-131***

Propagation time = $\frac{d}{S} = \frac{36000X10^3}{2.4X10^8}$ = 0.15 s = 150 ms
Transmission time = $\frac{size\ of\ the\ message}{bandwidth} = \frac{3X10^3X8}{10X10^6}$ = 2.4X10^-3 s = 2.4 ms

3. We are given a medium that will reliably transmit frequencies between 0 and 25,000Hz. Find the minimum signal level to transmit 200 Kbps of information along this line? [1]

Solution: ***by Younus-131***

Bandwidth, B = 25000 - 0 = 25000 Hz = 25 KHz

Nyquist Formula, C = 2B log_2 M

=> log_2 M = $\frac{C}{2B}$

=> M = $2^{\frac{C}{2B}} = 2^{\frac{200}{2X25}} = 16$

4. We need a three-stage time-space-time switch with N = 400. We use 20 TSIs at the first and third stages and 4 crossbars at the middle stage. [3]

a. Calculate the total number of crosspoints. [1]

b. Calculate the total number of memory locations we need for the TSIs. [2]

Solution:

a. Total number of crosspoints = no.of crossbar * (no. of TSI at first stage * no. of TSI at third stage) = 4 * (20 * 20)

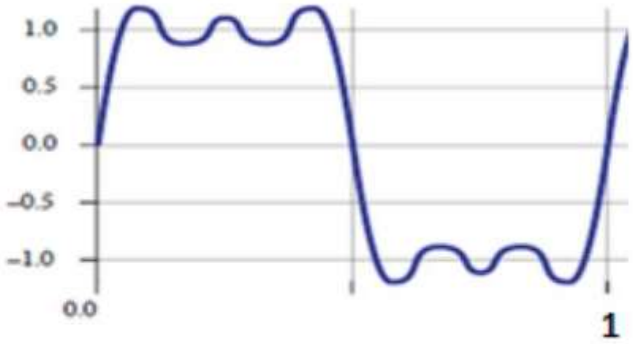
b. Each TSI has 400/20 = 20 input

Total of slot number in first stage = 20*20= 400

Total of slot number in third stage = 20*20= 400

Total number of memory locations we need for the TSIs= 400 + 400 = 800

5. Consider the following wave form as bit string of 1s and 0s and frequency components are 2f, 4f, 6f, 8f. Find the bandwidth and data rate of the signal. [2]



Solution:

Ekhane time er unit dewa nai, jodi time er unit ***microsecond*** hoy taholee solution nicher ta …

by Younus-131

Frequency, f = 1/T = 1 / (1 X 10^-6) = 1 X 10^6 Hz = 1 MHz

Bandwidth = 7f - 1f = 6f = 6 MHz

Data Rate = 2f = 2 Mbps