Semester Final Solutions

Lecture 1,2,3

Origin42 Final

1. a. What is LATA? What are the main components of inter-LATA services? How does a subscriber make a connection with another subscriber in interLATA services? [5]

Solution: O24

LATA(Local Access Transport Area.): A LATA is a geographical area where a local telephone company may carry both local calls and toll calls.

Main components of inter-LATA service:

1. Subscriber
2. End office
3. Tandem office
4. POP - Point Of Presence
5. IXC toll office - Inter Exchange Carrier
6. IXC network

A subscriber who needs to make a connection with another subscriber is connected first to an end switch and then, either directly or through a tandem switch, to a POP. The call now goes from the POP of an IXC (the one the subscriber has chosen) in the source LATA to the POP of the same IXC in the destination LATA. The call is passed through the toll office of the IXC and is carried through the network provided by the IXC.

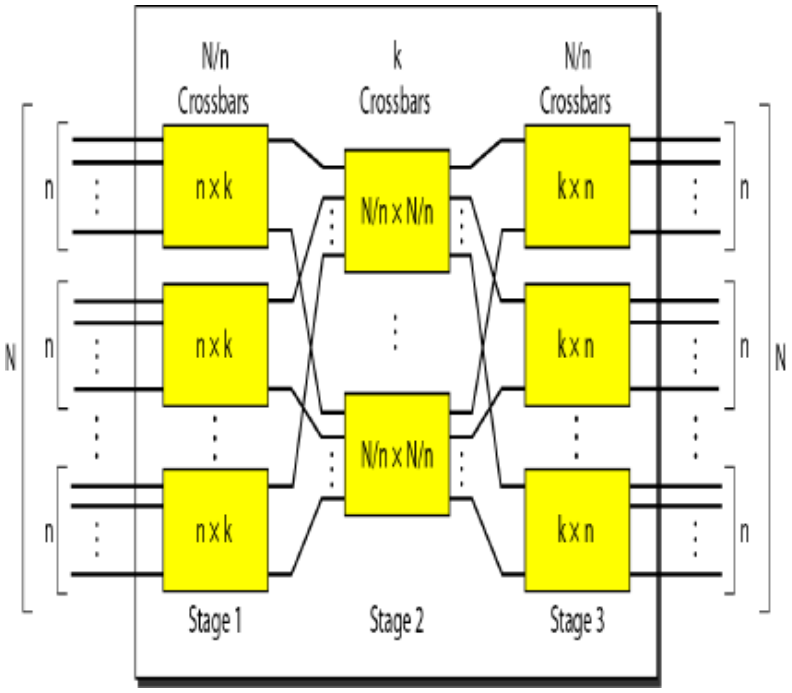
1. b. Describe the need for switching and design a three-stage switch of 100 x 100 using Clos criteria. [5]

Solution: O24

A network is a set of connected devices. Some of the conventional ways of interconnecting devices are: point-to-point connection between devices as in a mesh topology. **Connection between a central device and every other device as in star topology. Bus topology – not practical if the devices are at great distances. All these techniques require extensive cabling, dependence on a central server or a central bus. The solution to this interconnectivity problem is switching.**

Given, N = 100
For Clos criterion,
n = sqrt(N/2) = 7

k >= 2n-1 = 13



(put N, n, k values in the diagram)

1. c. You are trying to design a cellular network that will cover an area of at least 2800 km². There are K=300 available voice channels. Your design is required to support at least 100 concurrent calls in each cell. If the co-channel cell center distance is required to be 9 km, how many base stations will you need in this network? Also find the signal-to-co-channel interference ratio with path-loss exponent is 4. [4]

Solution: O24

Total area = 2800 km^2

K = 300 voice channel means each cluster can have 300 channel.

Need to support 100 concurrent call in each cell means N = 300/100 = 3

Co-channel cell center distance, D = R x sqrt(3xN) => 9 km = R x sqrt(3x3) => R = 3 km

Each cell area = (3 x sqrt(3) / 2) x R^2 = 23.3826859

Required base station = 2800 / 23.3826859 = 119.7467225 ~ 120

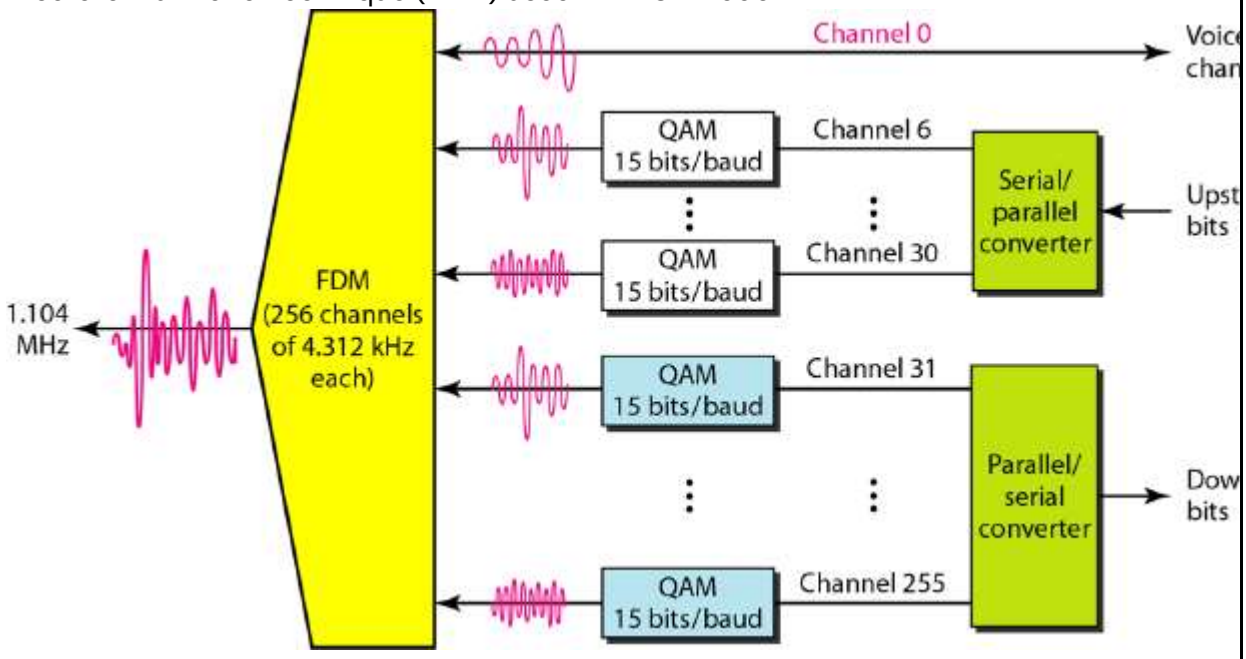
SIR = (D / R)^n / 6 = 13.5

Enigma41 Final

1.a. Describe discrete multitone technique (DMT) used in ADSL modem with a diagram and how do we get 1.44 Mbps upstream and 13.4 Mbps downstream data rate for ADSL Modem? [5]

Solved: O24

Discrete Multitone Technique (DMT) used in ADSL modem:



Each channel data transfer rate = 4.312 KHz ~ 4 KHz
QAM speed = 15 bits/baud

Upstream channel (6 to 30) = 25 channel (24 traffic channel + 1 control channel)
Upstream speed = 24 x 4 KHz x 15 bits/baud = 1440000 bps = 1.44 Mbps

Downstream channel (31 to 255) = 225 channel (224 traffic channel + 1 control channel)
Downstream speed = 224 x 4 KHz x 15 bits/baud = 13440000 bps = 13.44 Mbps

1.b. Show the mathematical expression of the frequency components of the square wave. What happens if we limit the bandwidth to just the first three frequency components? Explain with an example. [5]

Solved: O24

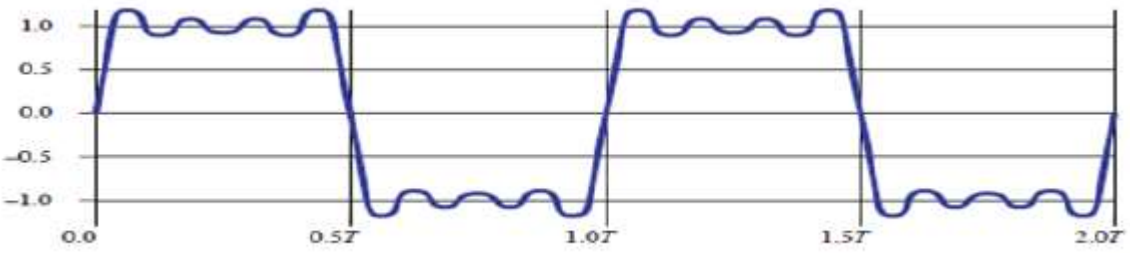
Mathematical expression of the frequency components of the square wave:

$$s(t) = A \times (4/\pi) \times \sum_{k\,odd\,k=1}^{\infty} sin(2\pi ft)/k$$

If we limit the bandwidth to just the first three frequency components:

Frequency components = 1f, 3f, 5f

$(4/\pi)\,[\sin(2\pi ft) + (1/3)\sin(2\pi(3f)t) + (1/5)\sin(2\pi(5f)t)]$



(b) $(4/\pi)\,[\sin(2\pi ft) + (1/3)\sin(2\pi(3f)t) + (1/5)\sin(2\pi(5f)t) + (1/7)\sin(2\pi(7f)t)]$

1.c. How is blocking related to a crossbar switch and multistage switch? How does a multistage switch alleviate the blocking problem? [4]

Solved: O24

Blocking: Blocking refers to times when one input cannot be connected to an output because there is no path available between them means all the possible intermediate switches are occupied.

- In a single-stage crossbar switch, blocking does not occur because every combination of input and output has its own crosspoint; there is always a path.
- In a multistage switch, The small number of crossbars at the middle stage creates blocking; if k < n , the switch is blocked.

A multistage switch alleviates the blocking problem by following Clos criteria. They are-
n = sqrt(N/2)
k >= 2n-1

Recursive40 Final

1.a. What is LATA? What are intra-LATA and inter-LATA services?

Solution: O24

LATA(Local Access Transport Area.): A LATA is a geographical area where a local telephone company may carry both local calls and toll calls.

There are two types of services:

1. Intra-LATA services: The services offered by the common carriers (telephone companies) inside a LATA are called intra-LATA services.

2. Inter-LATA services: The services between LATAs offered by the IXCs are called inter-LATA services.

1.b. Describe with an example the relationship between bandwidth and data rate when considering three frequency components of a pulse?

Solution: O24

Case 1:

- Let f = 10^6 cycles/sec = 1 MHz
- Frequency components = 1f, 3f, 5f
- Bandwidth = 5f – f = 4f = 4 MHz
- T = 1/ 10^6 = 10^{-6} = 1μs
- If we treat this wave form as bit string of 1s and 0s, 1 bit occurs at every 0.5 μs, i.e duration of each pulse is 1/2* 10^6
- Data rate = 2 * 10^6 = 2Mbps
- Thus for 4 MHz BW data rate is 2 Mbps

Case 2:

- Let f = 2*10^6 cycles/sec = 2 MHz
- Frequency components = 1f, 3f, 5f
- Bandwidth = 5f – f = 4f = (5*2*10^6 - 2*10^6) = 8 MHz
- T= 1/ 2 *10^6 = 0 .5 μs
- If we treat this wave form as bit string of 1s and 0s, 1 bit occurs at every 0.25 μs i.e duration of each pulse is 1/4* 10^6
- Data rate = 4* 10^6 = 4Mbps
- Thus for 8 MHz BW data rate is 4 Mbps

Same signal quality (Compare case 1 and 2)
Bandwidth ↑
Data rate ↑

1.c. What are the propagation time and the transmission time for a 2.5 kbyte message if the bandwidth of the network is 1 Gbps? Assume that the distance between the sender and the receiver is 12,000 km and the light travels at 2.4x10^8 m/s.

Solution: O24

Propagation time (delay) = Distance / Speed = 12000 Km / 2.4x10^8 m/s = 0.05 s
Transmission time (delay) = Message size / Data rate = 2.5 KB / 1 Gbps = 2x10^-5 s