Data Communication Assignment 2

Introduction to Data Communication and Networking (De Anza College)

Assignment 2

Ch 4 Problems: p.131 # P4-3, P4-6, P4-8, P4-14

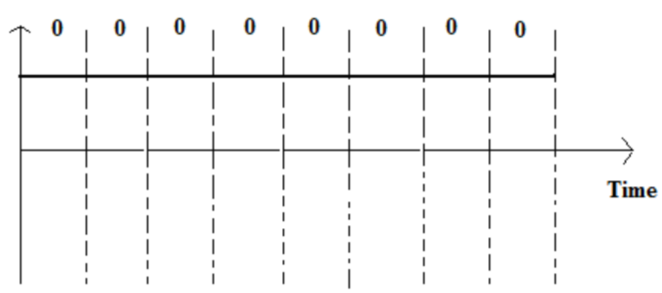
P4-3: Draw the graph of the NRZ-L scheme using each of the following data streams, assuming that the last signal level has been positive. From the graphs, guess the bandwidth for this scheme using the average number of changes in the signal level. Compare your guess with the corresponding entry in Table 4.1.

a. 00000000 b. 11111111 c. 01010101 d. 00110011

Category	*Scheme*	*Bandwidth (average)*	*Characteristics*
Unipolar	NRZ	$B = N/2$	Costly, no self-synchronization if long 0s or 1s, DC
Polar	NRZ-L	$B = N/2$	No self-synchronization if long 0s or 1s, DC
	NRZ-I	$B = N/2$	No self-synchronization for long 0s, DC
	Biphase	$B = N$	Self-synchronization, no DC, high bandwidth
Bipolar	AMI	$B = N/2$	No self-synchronization for long 0s, DC
Multilevel	2B1Q	$B = N/4$	No self-synchronization for long same double bits
	8B6T	$B = 3N/4$	Self-synchronization, no DC
	4D-PAM5	$B = N/8$	Self-synchronization, no DC
Multitransition	MLT-3	$B = N/3$	No self-synchronization for long 0s

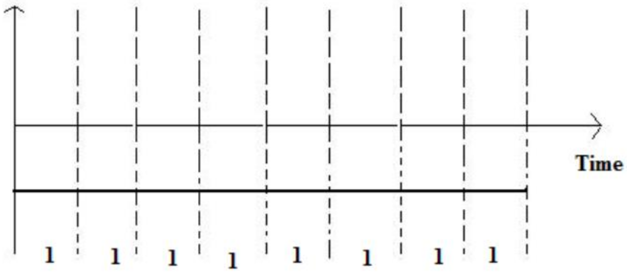
Answer:

a. 00000000
NRZ-L:



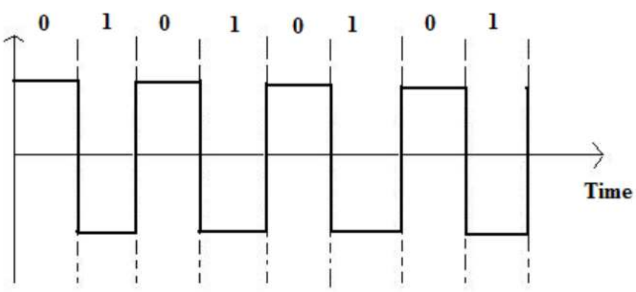
No. of changes=0

b. 11111111
NRZ-L:



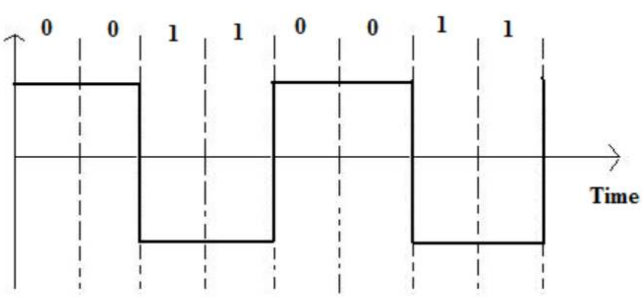
No. of changes=0

c. 01010101
NRZ-L:



No. of changes=8

d. 00110011
NRZ-L:



No. of changes=4

Now, Average number of changes= (0+0+8+4)/4=3

The Data Rate (N) defines the number of data elements. Here it has given 8 data streams.

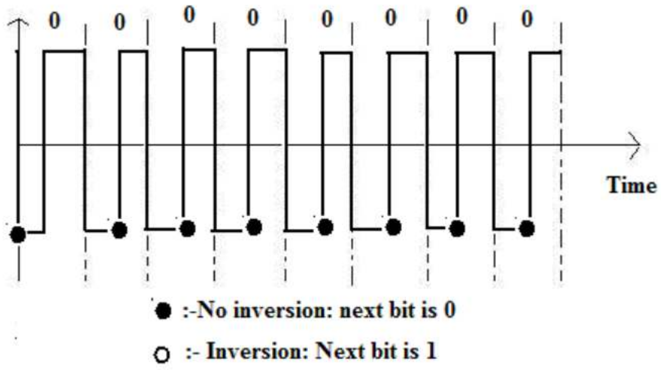
Thus, N=8.

Therefore, Bandwidth B is proportional to (3/8)N which is range B=0 to N.

P4-6. Repeat Problem P4-3 for the differential Manchester scheme.

a. 00000000

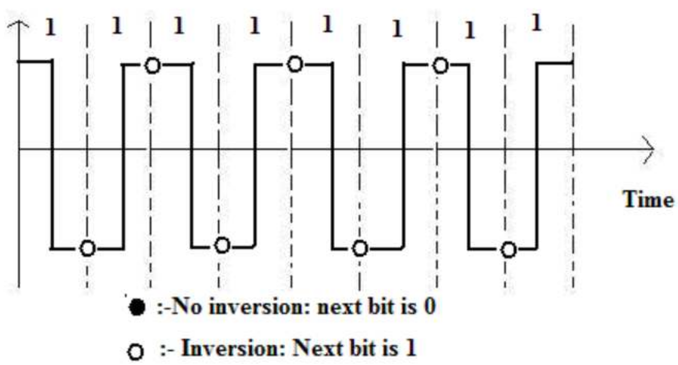
Differential:



No. of Changes=16

b. 11111111

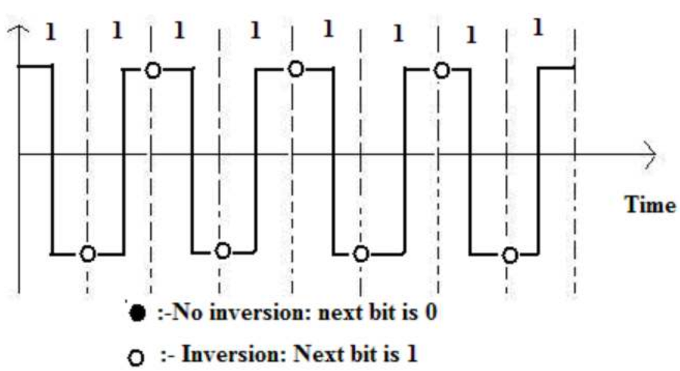
Differential:



No. of changes= 8

c. 0101010101

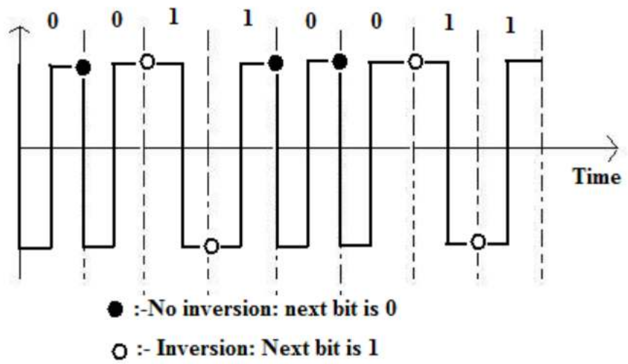
Differential:



No. of changes= 12

d. 00110011

Differential:



No. of changes= 12

Now, Average number of changes= (16+8+12+12)/4=12

The Data Rate (N) defines the number of data elements. Here it has given 8 data streams.

Thus, N=8.

Therefore, Bandwidth B is proportional to (12/8)N which is range B=N to 2N.

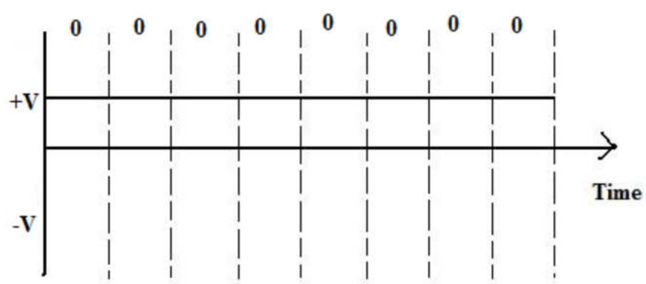
P4-8. Repeat Problem P4-3 for the MLT-3 scheme, but use the following data streams.

a. 00000000 b. 11111111 c. 01010101 d. 000111000

Answer:

a. 00000000

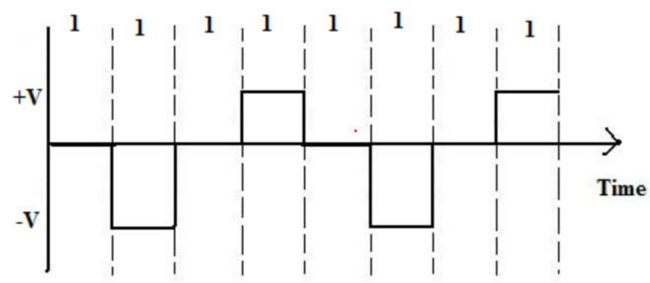
MLT-3:



No. of Changes=0

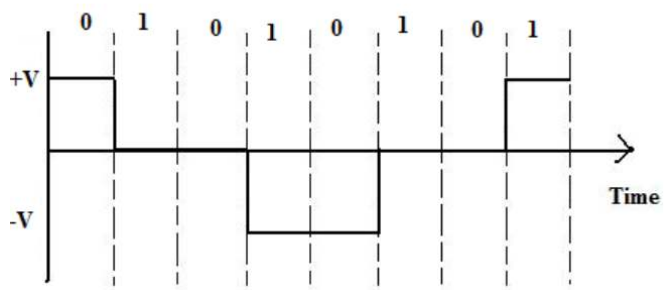
b. 11111111

MLT-3:



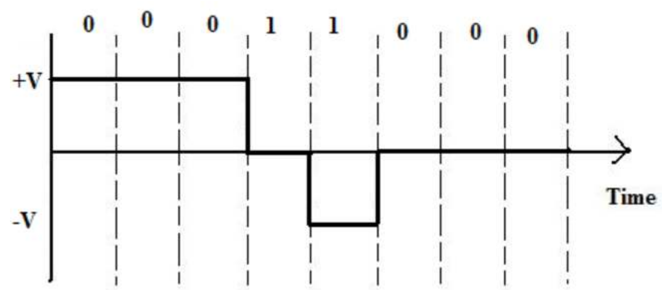
No. of changes=7

c. 01010101
MLT-3:



No. of Changes=4

d. 000111000
MLT-3:



No. of Changes=3

Now, Average number of changes= (0+7+4+3)/4=3.5

The Data Rate (N) defines the number of data elements. Here it has given 8 data streams.

Thus, N=8.

Therefore, Bandwidth B is proportional to (3.5/8)N which is range B=0 to N/2.

P4-14. What is the result of scrambling the sequence 11100000000000 using each of the following scrambling techniques? Assume that the last non-zero signal level has been positive.

a. B8ZS

b. HDB3 (The number of nonzero pulses is odd after the last substitution.)

Answer: The scrambling sequence is 11100000000000.

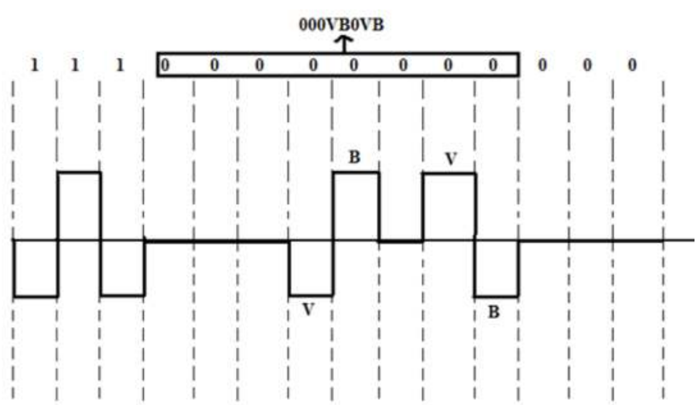
Assume that the last non-zero signal level has been positive.

a) B8ZS (Bipolar with 8-zero substitution):
   B8ZS substitutes eight consecutive zeros with **000VB0VB**.

   The V in the sequence denotes 'violation'; this is a nonzero voltage that breaks an AMI rule of encoding (opposite polarity from the previous).

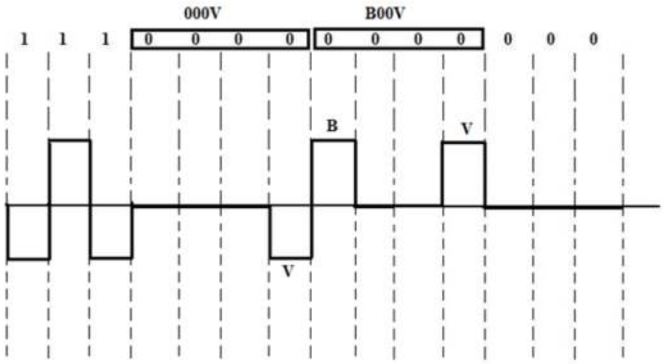
   The B in the sequence denotes 'bipolar', which means a nonzero level voltage in accordance with the AMI rule. AMI means alternate 1 inversion. A neutral zero voltage represents binary 0. Binary 1s are represented by altering positive and negative voltages.

   Now above scrambling technique follows then the result scrambling the sequence is



b) HDB3 (h density bipolar 3-zero):
HDB3 substitutes four consecutive zeros with 000V or B00V depending on the number of nonzero pulses after the last substitution.
The two rules can be follows:

1. If the number of nonzero pulses after the last substitution is odd, the substitution pattern will be 000V, which makes the total number of nonzero pulses even.
2. If the number of nonzero pulses after the last substitution is even, the substitution pattern will be B00V, which makes the total number of nonzero pulses even.



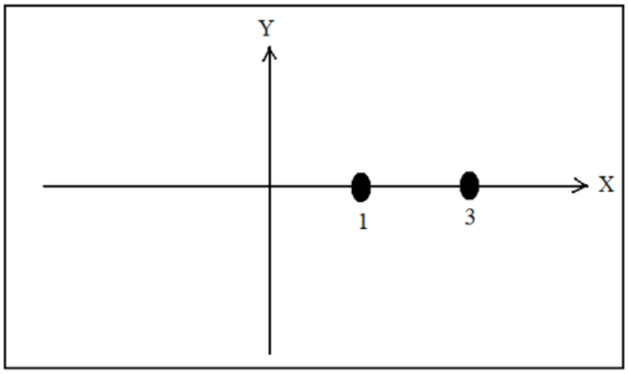
Given the number of nonzero pulses is odd after the last substitution. So, first substitution is 000V (from rule 1). The second substitution is B00V because there are no nonzero pulses after the first substitution (even).

Ch 5 Problems: p.153 # P5-4, P5-6, P5-8

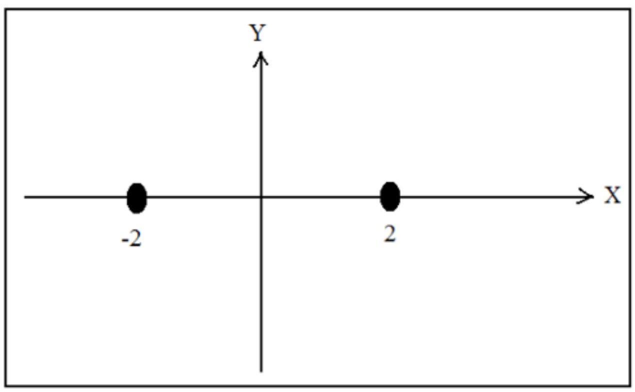
P5-4: Draw the constellation diagram for the following:
a. ASK, with peak amplitude values of 1 and 3
b. BPSK, with a peak amplitude value of 2
c. QPSK, with a peak amplitude value of 3
d. 8-QAM with two different peak amplitude values, 1 and 3, and four different phases.

Answer: A constellation diagram can help us define the amplitude and phase of a signal element, particularly when we are using two carriers (one in-phase and one quadrature). The diagram is useful when we are dealing with multilevel ASK, PSK, or QAM.
In a constellation diagram, a signal element type is represented as a dot. The bit or combination of bits it can carry is often written next to it.
The diagram has two axes. The horizontal X axis is related to the in-phase carrier; the vertical Y axis is related to the quadrature carrier.

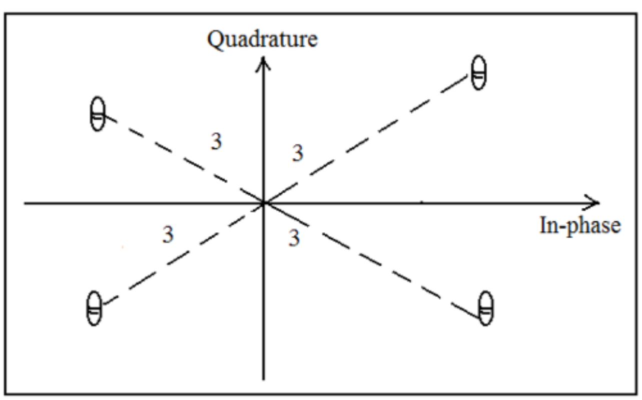
a. ASK, with peak amplitude values of 1 and 3



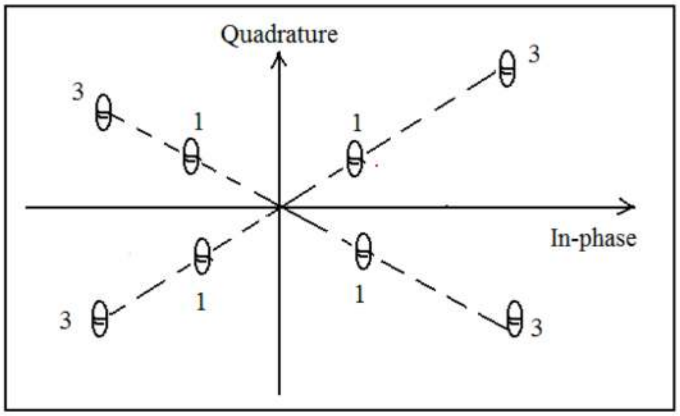
b. BPSK, with a peak amplitude value of 2



c. QPSK, with a peak amplitude value of 3



d. 8-QAM with two different peak amplitude values, 1 and 3, and four different phases.



P5-6: How many bits per baud can we send in each of the following cases if the signal constellation has one of the following number of points.

Answer: The number of bits per baud is the value of r = Log_2^L bit/baud.

The number of points defines the number of levels, L.

a) L=2
   Therefore, r = Log_2^2 = 1
   r = 1 bit/baud

b) L=4
   Therefore, r = Log_2^4 = 2 Log_2^2 = 2
   r = 2 bits/baud

c) L=16
   Therefore, r = Log_2^{16} = 4 Log_2^2 = 4
   r = 4 bits/baud

d) L=1024
   Therefore, r = Log_2^{1024} = 10 Log_2^2 = 10
   r = 10 bits/baud

P5-8: The telephone line has 4 KHz bandwidth. What is the maximum number of bits we can send using each of the following techniques? Let d = 0.

a. ASK   b. QPSK   c. 16-QAM   d. 64-QAM

Answer:

B= 4 KHz
d= 0

a. ASK is binary which means it contains two types of signal elements i.e., 0 and 1.
So, L=2

Then, r= Log_2^L = Log_2^2 = 1

Therefore, maximum number of bits, N= (Bxr)/(1+d)
= (4x1)/(1+0)
= 4 kbps

b. For QPSK, 2 bits are carried by 1 signal element. Hence, L=4.

Then, r= Log_2^L = Log_2^4 = 2 Log_2^2 = 2

Therefore, maximum number of bits, N= (Bxr)/(1+d)
= (4x2)/(1+0)
= 8 kbps

c. For 16-QAM, L=16

Then, r= Log_2^L = Log_2^{16} = 4 Log_2^2 = 4

Therefore, maximum number of bits, N= (Bxr)/(1+d)
= (4x4)/(1+0)
= 16 kbps

d. For 64-QAM, L=64

Then, r= Log_2^L = Log_2^{64} = 6 Log_2^2 = 6

Therefore, maximum number of bits, N= (Bxr)/(1+d)
= (4x6)/(1+0)
= 24 kbps

Ch 6 Problems: p.182 # P6-2, P6-8, P6-10, P6-14

P6-2: We need to transmit 100 digitized voice channels using a passband channel of 20 KHz. What should be the ratio of bits/Hz if we use no guard band?

Answer: Given : Number of voice channels= 100

The desired bandwidth apportions to each and every voice channel is 20 KHz / 100

= 20000 Hz /100 = 200 Hz

Each compute voice channel has a data rate of 64 Kbps

i.e., 8000 sample x 8 bits/sample = 64 kbps

Hence, if no guard band is used, then the ratio of bits/Hz would be (64000/200) bits/Hz

=**320 bits/Hz**

P6-8: Four channels, two with a bit rate of 200 kbps and two with a bit rate of 150 kbps, are to be multiplexed using multiple-slot TDM with no synchronization bits. Answer the following questions:

a. What is the size of a frame in bits?
b. What is the frame rate?
c. What is the duration of a frame?
d. What is the data rate?

Answer:

a. We can allocate the two channels with bit rate 200kbps into 4 bits with bit rate 100kbps.

Therefore, 2 × 200= 400 = 4 × 100

We can allocate the two channels with bit rate 150kbps into 3 bits with bit rate 100kbps.
Therefore, 2 × 150 = 300 = 3 × 100

Hence, **size of the frame in bits** = (4 × 2) + (3 × 2) = 8+6 = **14 bits**

b. Each output frame carries 4 bits from each of the 200 kbps source channels or 3 bits from each of the 150 kbps source channels.
Hence, the **frame rate** = 200kbps/4bits or 150kbps/3bits = **50000 frames/s**

c. **Duration of a frame** = 1/frame rate
= 1/50000
= 0.00002 s
= **20 µs**

d. **Output data rate** = (50000 frames/s) × (14 bits/frame)
= **700 kbps**

P6-10: Answer the following questions about a T-1 line:
a. What is the duration of a frame?
b. What is the overhead (number of extra bits per second)?

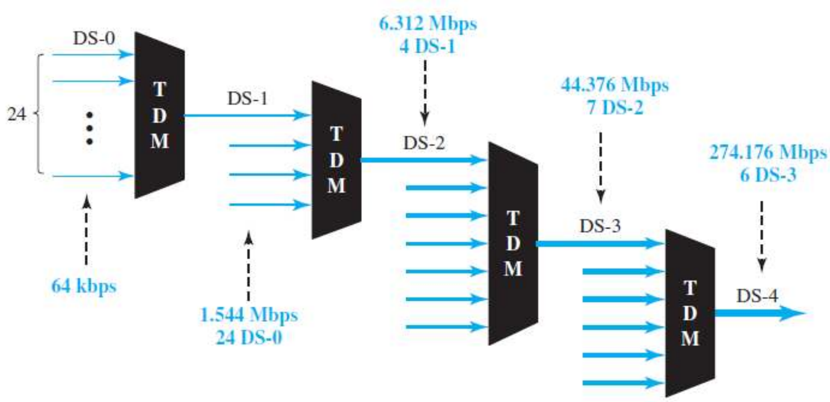
Answer: A T-1 line carries 8000 frames/s.

a. **Duration of a frame** = 1/8000 = 0.000125 = **125 µs**

b. Since each frame carries 1 extra bit/s.
The **Overhead** = 8000 × 1 = 8000 bps = **8kbps**

P6-14: Answer the following questions about the digital hierarchy in Figure 6.23:
a. What is the overhead (number of extra bits) in the DS-1 service?
b. What is the overhead (number of extra bits) in the DS-2 service?
c. What is the overhead (number of extra bits) in the DS-3 service?
d. What is the overhead (number of extra bits) in the DS-4 service?

Figure 6.23 *Digital hierarchy*



Answer:

a. The overhead (number of extra bits) in the DS-1 service:
DS-1 is a 1.544 Mbps service and it is 24 times DS-0 (i.e., 64 kbps) plus some overhead.
Hence, **DS-1 overhead**= 1544 – (24×64) = 1544 – 1536 = **8 kbps**

b. The overhead (number of extra bits) in the DS-2 service:
DS-2 is a 6.312 Mbps service and it is (24×4) times DS-0 (i.e., 64 kbps) plus some overhead.
Hence, **DS-2 overhead**= 6312 – (24×4×64) = 6312 – 6144 = **168 kbps**

c. The overhead (number of extra bits) in the DS-3 service:
DS-3 is a 44.376 Mbps service and it is (24×4×7) times DS-0 (i.e., 64 kbps) plus some overhead.
Hence, **DS-3 overhead**= 44,376 – (24×4×7×64) = 44,376 – 43,008 = **1.368 Mbps**

d. The overhead (number of extra bits) in the DS-4 service:
DS-4 is a 274.176 Mbps service and it is (24×4×7×6) times DS-0 (i.e., 64 kbps) plus some overhead.
Hence, **DS-4 overhead**= 274,176 – (24×4×7×6×64) = 274,176 – 258,048 = **16.128 Mbps**