What odd-parity ASCII character is being communicated by the Manchester encoded signal shown (bit 0 is sent first)? Each vertical division (every 0.5 ms) is a single bit-time.

$1110\ 0011 \Rightarrow \text{‘c’}$  
$1100\ 0111 \Rightarrow \text{‘G’}$
One of the responsibilities of layer 3 of the OSI model is managing packet flow to minimize or avoid congestion. In a connectionless service, packets can be routed around congestion. Is this also true for connection-oriented service? why or why not?

NO: dedicated connection path established at start, can’t change packet’s route thereafter
A signal, arriving at the receiver, is only 1% as strong as when it was sent. What is the signal strength loss in dB?

3.8, 3.92
A signal, arriving at the receiver, is only 1% as strong as when it was sent. What is the signal strength loss in dB?

\[ 10 \times \log_{10} \left( \frac{P_{\text{meas}}}{P_{\text{ref}}} \right) \text{ dB} \]

\[ 10 \times \log_{10} (0.01) \text{ dB} \]

\[ 10 \times \log_{10} (10^{-2}) \text{ dB} \]
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\[ 10 \times \log_{10} (0.01) \text{ dB} = \]
\[ 10 \times \log_{10} (10^{-2}) \text{ dB} = \]
\[ 10 \times (-2) = -20 \text{ dB} \]

In digitizing human speech for telephone transmission it is common to limit the high frequency components to 4,000 Hz and below. Suppose we represent each sample in an 8-bit byte. Show what the channel bandwidth must be to carry this digitized speech.
4. In digitizing human speech for telephone transmission it is common to limit the high frequency components to 4,000 Hz and below. Suppose we represent each sample in an 8-bit byte. Show what the channel bandwidth must be to carry this digitized speech.

Nyquist: 4,000 Hz signal \(\Rightarrow\) 8,000 samples/sec

each sample is 8 bits

\[
\therefore \ 8000 \text{ samples/sec} \times 8 \text{ bits/sample} \Rightarrow 64,000 \text{ bits/second}
\]

5. What is the Hamming distance between the even-parity encodings of the ASCII characters ‘A’ and ‘B’?

4.56, 4.57
What is the Hamming distance between the even-parity encodings of the ASCII characters ‘A’ and ‘B’?

• parity in use on ASCII characters ⇒ 8-bit codewords
• to detect single-bit errors, Hamming distance must be 2

\[ 0100\ 0001 \oplus 0100\ 0010 = 0000\ 0011 \]

\[ 01000001\]
\[ 01000100\]
\[ 00000011\]
In transmitting data on a wire, the bits appear as state values of some signal on the wire. Suppose the receiver samples the wire \( k \) times per second. What is this rate of \( k \) samples per second called? What does knowing \( k \) tell you about the bit rate? 2.6, 2.7

\[ \text{bit rate} \geq \text{baud rate} \]

\[ C = k \log_2(N) \] is not a useful answer unless you explain what \( N \) is, and state what \( C \) is.
If an ISDN basic rate service has 2 B-channels and 1 D-channel, what would the aggregate total capacity of the basic rate service be if you could combine all three channels?

2 × B-channel + 1 × D-channel = aggregate speed

2 × 64 kbps + 1 × 16 kbps = 144 kbps
Some frame \( i \) has just been correctly received using a sliding-window protocol. Assume the window was empty, so now it contains the one frame, \( i \). Suppose the receiver, which uses \( n \)-bit sequence numbers, wants to acknowledge that it has correctly received frame \( i \). What sequence number value does the receiver send if (i) using Go-Back-N? (ii) Selective Repeat protocol?

5.48, 5.53

Go-Back-N: \( RN = (RN + 1) \mod 2^n \Rightarrow (i + 1) \mod 2^n \)

Selective Repeat: \( i \)
Suppose you have a source of a single ‘pure’ audio frequency or tone (like a tuning fork) for 900 Hz. Given that $\lambda = \frac{v}{f}$, what is the length of one cycle of this tone in this room? (Hint: an acceptable approximation to $v_{\text{sound in this room}}$ is $3 \times 10^2$ m/sec). [Bonus [2]: what is the length of 1 cycle of this tone in a vacuum?]

$\lambda_{\text{room}} = \frac{v}{f} = \frac{300 \text{ m/sec}}{900 \text{ cycles/sec}} = \frac{1}{3} \text{ m}$
9. Suppose you have a source of a single ‘pure’ audio frequency or tone (like a tuning fork) for 900 Hz. Given that \( \lambda = \frac{v}{f} \), what is the length of one cycle of this tone in this room? (Hint: an acceptable approximation to \( v_{\text{sound in this room}} \) is \( 3 \times 10^2 \) m/sec). [Bonus [2]: what is the length of 1 cycle of this tone in a vacuum?]

\[
\lambda_{\text{vacuum}} = \frac{v}{f} = \frac{0 \text{ m/sec}}{900 \text{ cycles/sec}} = 0 \text{ m}
\]

10. Flooding may seem to be a drastic way to route packets, but it is effective. Flooding offers other advantages. Name and briefly describe one of these advantages.

lecture presentation of 7.47
Flooding may seem to be a drastic way to route packets, but it is effective. Flooding offers other advantages. Name and briefly describe one of these advantages.

1. all routes are tried/explored

2. discover minimal hop-count route
10 Flooding may seem to be a drastic way to route packets, but it is effective. Flooding offers other advantages. Name and briefly describe one of these advantages.

1. all routes are tried/explored
2. discover minimal hop-count route
3. all nodes visited ⇒ broadcast

11 Show what the LZ compressed version of the message “the one phone or the other” would look like – work only with groupings of 2 or more characters (as we did in class). For your convenience, the message is reprinted below, with the character positions numbered:

000000000111111112222222
12345678901234567890123456
the one phone or the other
Show what the LZ compressed version of the message “the one phone or the other” would look like – work only with groupings of 2 or more characters (as we did in class). For your convenience, the message is reprinted below, with the character positions numbered:

```
000000000111111112222222
12345678901234567890123456
```

```
the one phone or the other
```

“the”: 1-3

```
the one phone or [1-3] o[1-3]r
```

MTSOL.29

Show what the LZ compressed version of the message “the one phone or the other” would look like – work only with groupings of 2 or more characters (as we did in class). For your convenience, the message is reprinted below, with the character positions numbered:

```
000000000111111112222222
12345678901234567890123456
```

```
the one phone or the other
```

“the”: 1-3

```
the o": 1-5
```

```
the one phone or [1-5][1-3]r
```

MTSOL.30
Show what the LZ compressed version of the message “the one phone or the other” would look like – work only with groupings of 2 or more characters (as we did in class). For your convenience, the message is reprinted below, with the character positions numbered:

0000000001111111112222222
12345678901234567890123456

the one phone or the other

“the”: 1-3
“the o”: 1-5
“one ”: 5-8

the one ph[5-8]or [1-5][1-3]r

alternative version:

the on[3-4]ph[5-7][4-5]r [1-5][1-3]r
Suppose we work with frames of length 10 kbits and a channel capacity of 2 Mbps. The link is a copper wire connecting two machines that are 420 m apart, and is very reliable. Assuming that the processing times at either end are negligible, that the frame transmit times are the same at both ends (i.e., $T_F = T_A$), and there are no other delays of any kind, what would you suggest as a reasonable timeout value, e.g., for stop-and-wait with timeout to use?

5.32, 5.27

\[ \tau > S = T_A + 2D + T_F + P_F + P_A \]

\[ T_F = \frac{L}{C} \quad \text{(length/rate)} \]

\[ D = \text{distance}/v_{medium} \]
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$$\tau > S = 2T_F + 2D$$

$$T_F = \frac{L}{C} = \frac{10,000 \text{ bits}}{2 \times 10^6 \text{ bits/sec}} = \frac{10^4}{2 \times 10^6} = \frac{1}{2} \times 10^{-2} = 5 \text{ ms.}$$

$$\tau > S = 2 \times (5 \text{ ms.}) + 2D$$

Suppose we work with frames of length 10 kbits and a channel capacity of 2 Mbps. The link is a copper wire connecting two machines that are 420 m apart, and is very reliable. Assuming that the processing times at either end are negligible, that the frame transmit times are the same at both ends (i.e., $T_F = T_A$), and there are no other delays of any kind, what would you suggest as a reasonable timeout value, e.g., for stop-and-wait with timeout to use?

$$\tau > S = 10 \text{ ms.} + 2D$$

$$D = \frac{\text{distance}}{v_{\text{medium}}} = \frac{420 \text{ m}}{2.1 \times 10^5 \text{ m/sec}} = \frac{210 \times 2}{210 \times 10^6} = \frac{2}{10^6} = 0.002 \text{ ms}$$

$$\tau > S = 10 \text{ ms.} + 2 \times (0.002 \text{ ms.})$$
Suppose we work with frames of length 10 kbits and a channel capacity of 2 Mbps. The link is a copper wire connecting two machines that are 420 m apart, and is very reliable. Assuming that the processing times at either end are negligible, that the frame transmit times are the same at both ends (i.e., $T_F = T_A$), and there are no other delays of any kind, what would you suggest as a reasonable timeout value, e.g., for stop-and-wait with timeout to use?

$\tau > S = 10 \text{ ms.} + 0.004 \text{ ms.} = 10.004 \text{ ms}$

round trip time (RTT)

When a node on a token-ring sends a frame, the A and C bits in the Frame Status field are both 0. When the frame returns to its originator, what does it mean if (i) A and C are both 1? (ii) A is 1 but C is 0?
When a node on a token-ring sends a frame, the A and C bits in the Frame Status field are both 0. When the frame returns to its originator, what does it mean if (i) A and C are both 1? (ii) A is 1 but C is 0?

- Address recognized
- Frame Copied

1 1  address recognized & frame copied $\Rightarrow$ successful delivery
1 0  address recognized & frame not copied $\Rightarrow$ failed delivery

Assume a perfect link that carries data at 20.48 kbps. How long does it take to transmit a 50 kilobyte file?

2.21, 2.53
Assume a perfect link that carries data at 20.48 kbps. How long does it take to transmit a 50 kilobyte file?

\[
\text{transmit time} = \frac{\text{amount of data bits}}{\text{speed of data bps}}
\]

\[
50 \times 8 \times 1024 = 400 \times 1024 \text{ bits}
\]
14

Assume a perfect link that carries data at 20.48 kbps. How long does it take to transmit a 50 kilobyte file?

\[
\begin{align*}
50 \times 8 \text{ bits/byte} \times 1024 &= 400 \times 1024 \text{ bits} \\
20.48 \times 1000 \text{ bits/second} &= 20 \times 1024 \text{ bps}
\end{align*}
\]

\[
\text{transmit time} = \frac{400 \times 1024 \text{ bits}}{20 \times 1024 \text{ bps}} = 20 \text{ seconds}
\]

15

If you could choose between using virtual circuit or datagram network models, why might you prefer datagrams if nodes in the network are known to be highly prone to failure?

7.25
If you could choose between using virtual circuit or datagram network models, why might you prefer datagrams if nodes in the network are known to be highly prone to failure?

Datagrams preferable because they can be routed around problem areas whereas a node failure in a VC wipes out entire circuit.

Recall that I specifically mentioned this as a possible question in lecture 7.

Suppose FT is a frame of bits to be transmitted over a link using CRC’s as part of its error handling mechanism. If the generator polynomial for the CRC system is \( x^4 + x^2 + x + 1 \), is the received frame FR: 1110 0010 1110 0101 1101 correct or not? State how you know.

4.73
Suppose FT is a frame of bits to be transmitted over a link using CRC’s as part of its error handling mechanism. If the generator polynomial for the CRC system is $x^4 + x^2 + x + 1$, is the received frame FR: 1110 0010 1110 0101 1101 correct or not? State how you know.

Need to perform CRC computation in order to know.

Need to know: (1) bit string for G(x),
(2) remainder from division (is 0 if no error)
The remainder is 0, so we know the frame is correct.

On some CSMA/CD link there have just been three consecutive collisions. Every time a collision is detected, each of the nodes waits some number $j$ of time slots before attempting to send again. What is the range of values $j$ may take on at this instant, just after the third consecutive collision?
17. On some CSMA/CD link there have just been three consecutive collisions. Every time a collision is detected, each of the nodes waits some number $j$ of time slots before attempting to send again. What is the range of values $j$ may take on at this instant, just after the third consecutive collision?

After each collision, each sender picks a random value for $j$ in the range of $0..2^j-1$ as the number of send-times it waits before sending.

With $j=3$, that range is $0..2^3-1 = 0..7$

18. The OSI 7-layer model is a classical model for the study of networks. Draw the seven layers, identifying each by its full name (i.e., not just with an acronym).
The OSI 7-layer model is a classical model for the study of networks. Draw the seven layers, identifying each by its full name (i.e., not just with an acronym).

1. physical layer
2. data link control
3. network layer
4. transport layer
5. session layer
6. presentation layer
7. application layer

Fill in the blanks; each is worth 1 point.

i. ______ is always present in any communications medium. <2.25>
Fill in the blanks; each is worth 1 point.

i. Noise is always present in any communications medium.

ii. ___ and ___ are two of many bodies that establish standards by which networks operate. <1.31-33,…>
Fill in the blanks; each is worth 1 point.

i. Noise is always present in any communications medium.
ii. IETF and IEEE are two of many bodies that establish standards by which networks operate.
iii. The kind of switching a network is using when an entire message transfer follows a single, fixed path through the network: circuit
iv. Sine waves whose frequencies are multiples of a frequency $f$, e.g., $2f$, $3f$, etc., are called harmonics
v. This kind of series can approximate any periodic function: ____________ <2.15>
Fill in the blanks; each is worth 1 point.

ii. IETF and IEEE are two of many bodies that establish standards by which networks operate.

iii. The kind of switching a network is using when an entire message transfer follows a single, fixed path through the network: circuit

iv. Sine waves whose frequencies are multiples of a frequency \( f \), e.g., \( 2f, 3f \), etc., are called harmonics

v. This kind of series can approximate any periodic function: Fourier

vi. A channel that picks up signal energy from other nearby signals is experiencing this kind of noise: crosstalk

vii. Ensuring that unauthorized changes to a message in a network cannot go undetected is ensuring message ________ <4.33>
Fill in the blanks; each is worth 1 point.

iv. Sine waves whose frequencies are multiples of a frequency $f$, e.g., $2f$, $3f$, etc., are called **harmonics**

v. This kind of series can approximate any periodic function: **Fourier**

vi. A channel that picks up signal energy from other nearby signals is experiencing this kind of noise: **crosstalk**

vii. Ensuring that unauthorized changes to a message in a network cannot go undetected is ensuring **message integrity**

viii. Links become more susceptible to error as **distance** increases. <4.45>

ix. A connection-oriented service whose packets are always provided in correct sequence is a _______ delivery service <5.9>
Fill in the blanks; each is worth 1 point.

vi. A channel that picks up signal energy from other nearby signals is experiencing this kind of noise: crosstalk

vii. Ensuring that unauthorized changes to a message in a network cannot go undetected is ensuring message integrity

viii. Links become more susceptible to error as distance increases.

ix. A connection-oriented service whose packets are always provided in correct sequence is a reliable delivery service

x. Two or more machines on a shared-resource link (like Ethernet) cause a collision if they begin transmitting packets at the same time. <6.9>

xi. The number of frames a node on a token-ring can send if it does not have the token is ___ <6.26>
Fill in the blanks; each is worth 1 point.

viii. Links become more susceptible to error as distance increases.
ix. A connection-oriented service whose packets are always provided in correct sequence is a reliable delivery service
x. Two or more machines on a shared-resource link (like Ethernet) cause a collision if they begin transmitting packets at the same time.
xi. The number of frames a node on a token-ring can send if it does not have the token is 0
xii. The number of bits in a MAC address in 802.3 (e.g., in an Ethernet frame) is __ <6.40>

Fill in the blanks; each is worth 1 point.

ix. A connection-oriented service whose packets are always provided in correct sequence is a reliable delivery service
x. Two or more machines on a shared-resource link (like Ethernet) cause a collision if they begin transmitting packets at the same time.
xi. The number of frames a node on a token-ring can send if it does not have the token is 0
xii. The number of bits in a MAC address in 802.3 (e.g., in an Ethernet frame) is 48
xiii. Selecting a path for packets through a network from source to destination is called _______ <7.13>
Fill in the blanks; each is worth 1 point.

x. Two or more machines on a shared-resource link (like Ethernet) cause a collision if they begin transmitting packets at the same time.

xi. The number of frames a node on a token-ring can send if it does not have the token is 0.

xii. The number of bits in a MAC address in 802.3 (e.g., in an Ethernet frame) is 48.

xiii. Selecting a path for packets through a network from source to destination is called routing.

xiv. A signal in a channel ranges from 1.5 kHz to 4.5 kHz has a bandwidth of 3.0 kHz.

<2.19>