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This review covers week two of the lectures. It WILL NOT count towards your overall grade.

### Question 1

What is the message latency to send a 500 byte message across a 4 Mbps link that has a delay of 5ms?

|  |  |  |  |
| --- | --- | --- | --- |
| **Your Answer** |  | **Score** | **Explanation** |
| 5 ms |  |  |  |
| 6 ms |  |  |  |
| 1 ms | Inorrect | 0.00 | That is the transmission delay. |
| 9 ms |  |  |  |
| Total |  | 0.00 / 1.00 |  |

**Question Explanation**L = M/R + D. We have M = 500 x 8 = 4000 bits, R = 4 Mbps, and D = 5ms. So L = 1ms + 5 ms = 6 ms

### Question 2

What is the maximum amount of data in flight for a 5 Mbps Internet access link with a delay of 4ms?

|  |  |  |  |
| --- | --- | --- | --- |
| **Your Answer** |  | **Score** | **Explanation** |
| 20 bytes |  |  |  |
| 2500 bytes | Correct | 1.00 |  |
| 25 kB |  |  |  |
| 200000 bits |  |  |  |
| Total |  | 1.00 / 1.00 |  |

**Question Explanation**The question asks for the bandwidth-delay product. BD = R x D, where R = 5 Mbps, and D = 4 ms. BD = 20 x 1000000 x 0.001 = 20000 bits = 2500 bytes

### Question 3

A modulation scheme uses 8 voltage levels, which we will call 0 through 7. Each voltage level is used to represent 3 bits according to its binary representation, e.g., voltage level 3 means " 0 1 1". *What sequence of voltage levels is used to send the bit sequence 010010001111?*

|  |  |  |  |
| --- | --- | --- | --- |
| **Your Answer** |  | **Score** | **Explanation** |
| 8 2 3 3 |  |  |  |
| 2 2 1 7 | Correct | 1.00 |  |
| 1 1 1 7 |  |  |  |
| 0 1 0 1 0 1 |  |  |  |
| Total |  | 1.00 / 1.00 |  |

**Question Explanation**Breaking the bits up in to 3 bit chunks, 010 = 2, 010 = 2, 001 = 1, and 111 = 7. So the sequence of voltage levels that is sent is 2 2 1 7.

### Question 4

A sequence of bits is 4B/5B mapped before it is sent. The result is: 1110011110. What were the original bits?

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| --- | --- | --- | --- |
| **Your Answer** |  | **Score** | **Explanation** |
| 00001110 |  |  |  |
| 11100000 | Correct | 1.00 |  |
| 01111110 |  |  |  |
| 11110001 |  |  |  |
| Total |  | 1.00 / 1.00 |  |

**Question Explanation**Dividing the mapped bits into chunks of 5 and using the tables in the slides, 1110 maps to 11100, and 0000 maps to 11110. The original sequence was 11100000

### Question 5

An 8 level signaling scheme is used to send information in a 5 MHz frequency band. *What is the maximum bit rate at which data can be transferred?* Use the Nyquist limit.

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| --- | --- | --- | --- |
| **Your Answer** |  | **Score** | **Explanation** |
| 80 Mbps |  |  |  |
| 30 Mbps | Correct | 1.00 |  |
| 10 Mbps |  |  |  |
| 20 Mbps |  |  |  |
| Total |  | 1.00 / 1.00 |  |

**Question Explanation**R = 2B log2 V, where V = 8 and B = 5 MHz. log2(8) = 3. So R = 2 . 5 . 3 Mbps = 30 Mbps

### Question 6

An 802.11 channel has 20 MHz of bandwidth. Assume that under good conditions, 802.11 signals are received with a signal-to-noise ratio (SNR) of roughly 1000. *What is the maximum rate at which information can be sent over an 802.11 link?* Use the Shannon limit.

|  |  |  |  |
| --- | --- | --- | --- |
| **Your Answer** |  | **Score** | **Explanation** |
| 60 Mbps | Inorrect | 0.00 | Did you take log10() instead of log2()? |
| 200 Mbps |  |  |  |
| 400 Mbps |  |  |  |
| 20 Gbps |  |  |  |
| Total |  | 0.00 / 1.00 |  |

**Question Explanation**R = B log2(1 + SNR), with SNR = 1000 (or 30dB) and B = 20 MHz. log2(1+SNR) is close to 10. So R = 20 x 10 Mbps = 200 Mbps

### Question 7

A sequence of bytes received after byte stuffing using the PPP byte stuffing scheme is: 10 20 7D 5E 30 5E 7D 5D. *What is the unstuffed sequence?*

|  |  |  |  |
| --- | --- | --- | --- |
| **Your Answer** |  | **Score** | **Explanation** |
| 10 20 5E 30 5E 5D |  |  |  |
| 10 20 7E 30 5E 7D | Correct | 1.00 |  |
| 10 20 7E 30 5E 5D |  |  |  |
| 10 20 30 |  |  |  |
| Total |  | 1.00 / 1.00 |  |

**Question Explanation**Look for 7D and map 7D 5E to 7E, and 7D 5D to 7D. All other bytes are unchanged.

### Question 8

A bit stuffed string received from the network is 1110111110. *What is the string after any stuffing is removed?*

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| --- | --- | --- | --- |
| **Your Answer** |  | **Score** | **Explanation** |
| 11101111100 |  |  |  |
| 111011111 | Correct | 1.00 |  |
| 11111111 |  |  |  |
| 1110111110 |  |  |  |
| Total |  | 1.00 / 1.00 |  |

**Question Explanation**Look for 11111 (five 1s) and remove the following 0. In this case a single 0 at the end is removed.

### Question 9

An error code uses the codewords 0000, 0011, 1100 and 1111 . (They encode 00, 01, 10 and 11.) *How many errors can always be detected?* Use Hamming distance.

|  |  |  |  |
| --- | --- | --- | --- |
| **Your Answer** |  | **Score** | **Explanation** |
| 0 |  |  |  |
| 1 |  |  |  |
| 3 | Inorrect | 0.00 | Too large -- that is HD+1 |
| 2 |  |  |  |
| Total |  | 0.00 / 1.00 |  |

**Question Explanation**For the Hamming distance, look for the minimum number of bit flips to turn one codeword into any other codeword. It is 2, e.g., 0000 -> 0011 or 1100. With HD=2, the code can detect up to 1 error (i.e., d = 1 so d+1 = 2)

### Question 10

*Compute the parity bit to add to the bit string 1001011 to detect single bit errors.* (Use even parity as shown in the lectures.)

|  |  |  |  |
| --- | --- | --- | --- |
| **Your Answer** |  | **Score** | **Explanation** |
| 1 | Inorrect | 0.00 | This is true for odd parity, but we studied even parity. |
| 0 |  |  |  |
| 4 |  |  |  |
| 10010110 |  |  |  |
| Total |  | 0.00 / 1.00 |  |

**Question Explanation**Even parity used in the lectures simply adds up the bits to send mod 2, i.e., 1 + 0 + 0 + 1 + 0 + 1 + 1 = 4 = 0 mod 2. So the parity bit is 0

### Question 11

Consider the 7 bit Hamming code. Let the 7 bits of a codeword be represented by A B C D E F G. *Which positions are the DATA bits?*

|  |  |  |  |
| --- | --- | --- | --- |
| **Your Answer** |  | **Score** | **Explanation** |
| A B D |  |  |  |
| C E F G | Correct | 1.00 |  |
| A B C D |  |  |  |
| E F G |  |  |  |
| Total |  | 1.00 / 1.00 |  |

**Question Explanation**The check bits are in positions that are powers of 2: the 1st, 2nd, and 4th, i.e., A, B, and D. The other bits are the data bits.

Bottom of Form

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5 ms

9 ms

1 ms

6 ms

**Question 2**

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20 bytes

25 kB

200000 bits

2500 bytes

**Question 3**

A modulation scheme uses 8 voltage levels, which we will call 0 through 7. Each voltage level is used to represent 3 bits according to its binary representation, e.g., voltage level 3 means " 0 1 1". *What sequence of voltage levels is used to send the bit sequence 010010001111?*

2 2 1 7

0 1 0 1 0 1

1 1 1 7

8 2 3 3

**Question 4**

A sequence of bits is 4B/5B mapped before it is sent. The result is: 1110011110. What were the original bits?

00001110

11100000

01111110

11110001

**Question 5**

An 8 level signaling scheme is used to send information in a 5 MHz frequency band. *What is the maximum bit rate at which data can be transferred?* Use the Nyquist limit.

30 Mbps

80 Mbps

10 Mbps

20 Mbps

**Question 6**

An 802.11 channel has 20 MHz of bandwidth. Assume that under good conditions, 802.11 signals are received with a signal-to-noise ratio (SNR) of roughly 1000. *What is the maximum rate at which information can be sent over an 802.11 link?* Use the Shannon limit.

200 Mbps

60 Mbps

400 Mbps

20 Gbps

**Question 7**

A sequence of bytes received after byte stuffing using the PPP byte stuffing scheme is: 10 20 7D 5E 30 5E 7D 5D. *What is the unstuffed sequence?*

10 20 5E 30 5E 5D

10 20 30

10 20 7E 30 5E 7D

10 20 7E 30 5E 5D

**Question 8**

A bit stuffed string received from the network is 1110111110. *What is the string after any stuffing is removed?*

111011111

1110111110

11111111

11101111100

**Question 9**

An error code uses the codewords 0000, 0011, 1100 and 1111 . (They encode 00, 01, 10 and 11.) *How many errors can always be detected?* Use Hamming distance.

1

0

2

3

**Question 10**

*Compute the parity bit to add to the bit string 1001011 to detect single bit errors.* (Use even parity as shown in the lectures.)

1

4

0

10010110

**Question 11**

Consider the 7 bit Hamming code. Let the 7 bits of a codeword be represented by A B C D E F G. *Which positions are the DATA bits?*

C E F G

A B C D

E F G

A B D