COSC 350 Exam 1 Review

Problems from textbook:

1.8 What is a communication protocol? Conceptually, what two aspects of communication does a protocol specify?
1.12 Explain how headers are added and removed as data passes through a layered protocol stack.
6.20 If the maximum frequency audible to a human ear is 20,000 Hz, at what rate must the analog signal from a microphone be sampled when converting it to digital?
6.22 Describe the difference between lossy and lossless compression. Tell when each might be used.
7.4 What three types of wiring are used to reduce interference form noise?
7.14 Can laser communication be used from a moving vehicle? Explain.
8.9 How does one compute the minimum number of bit changes that can transform a valid codeword into another valid codeword?
9.4 What is the chief characteristic of asynchronous transmission?
9.7 When using a synchronous transmission scheme, what happens when a sender does not have data to send?
10.5 In phase shift keying, is it possible to have a phase shift of 90°? of 270°? of 360°?
11.6 Explain how a range of frequencies can be used to increase data rate.
12.6 What type of multiplexing does ADSL use?

Answers:

1.8 Protocols specify the details of network communication. A protocol specifies the format (syntax) and meaning (semantics) of messages i.e., specify fields in the protocol header and the message exchanges that occur.
1.12 Each layer adds/removes its header to/from the packet and passes the resulting packet to the layer below/above.
6.20 The sampling rate = $2\times f_{max}$, so 2x20,000 = 40,000 Hz (i.e. 40,000 samples/sec)
6.22 Lossy compression: some data is lost when compressing (for loss-tolerant streams e.g. video/audio). Lossless compression: original data is preserved and recovered on decompression (for loss-intolerant streams e.g. data files).
7.4 Coax, unshielded/shielded twisted pair (UTP/STP), optical fiber (carries light waves; is immune to electrical noise).
7.14 Difficult since line-of-sight and precise alignment is needed.
8.9 Hamming distance=# of bits in which two codewords differ. Compute dmin=min Hamming distance among all pairs of codewords=min # of errors that can change a valid codeword into another**.** Can detect at most (dmin-1) errors.
9. 4 Data can arrive at any time with an arbitrary gap between data items.
9.7 Start frame with a special sequence of bits for synchronization and transmit an idle byte when there is no data.
10.5 When modulating data, any phase shift can be used; 360-degree and 0-degree shifts are the same (see slides).
11.6 Divide the frequency range into K carriers and send 1/K of the data on each carrier.
12.6 ADSL combines FDM with inverse multiplexing in a scheme known as DMT (Discrete Multi Tone).

Additional questions (answers are in bold):

1. True or False? Circle ONE of T (true) or F (false) to indicate your answer.

- In the OSI 7-layer model, layer 3 is the network layer T F **T**
- UDP is a connection-oriented protocol T F **F**
- Voice packets in typical VoIP traffic use TCP instead of UDP T F **F**
- TCP provides many-to-many communication T F **F**
- A UDP message (=UDP header+UDP data) over IP cannot have more than 64 Kbytes T F **T**
- The destination IP address in packets sent by a client to a server is the client's IP T F **F**
- Concurrent servers use a separate thread of control for each client T F **T**
- The server port number identifies an application running on the server T F **T**
- A DNS request from a browser asks for a web server's MAC address T F **F**
- The TCP checksum in a received packet computed using the Internet checksum has 32 bits T F **F**
- For the CRC polynomial $x^{16}+x^{12}+x^5+1$, the total number of bits in the CRC is 16 T F **T**
- The CRC used in Ethernet or 802.11 frames can correct most burst errors T F **F**
- If the maximum number of detectable errors is 6, the minimum Hamming distance $d_{min}=6$ T F **F**
- For a (10, 5) encoding scheme, the number of data bits is 10 T F **F**
- For a (10, 5) encoding scheme, the code rate is 1/2 T F **T**
- The Hamming distance for the strings 1001 and 0011 is 2 T F **T**
- If 11000101 → 10001101, the length of the burst error is 4 T F **T**
- A RAC matrix can <u>correct</u> any single bit error T F **T**
- ADSL selects frequencies and modulation techniques to adapt to line quality: T F **T**

2. For each packet, show the relevant protocol headers in the <u>correct order:</u>

a) HTTP/2 request packet sent on an Ethernet by a browser to a Web server **Ethernet|IP|TCP|HTTP**
b) DNS response packet sent on an 802.11 networks and received by a client **802.11|IP|UDP|DNS**
c) ICMP ping packet sent on a wired link to an Ethernet switch by an 802.11 AP **Ethernet|IP|ICMP|**
d) ARP request sent by an 802.11 home router to a mobile device **802.11|ARP**

3. The TCP/IP model layers are Internet (I), Transport (T), Application (A), Physical (P), Network_Interface (N_I)

- Name the layer that contains each protocol: TCP___ IP____ FTP___ **transport Internet application**
- Name the layer that specifies low-level details such as modulation, frequencies and voltages ____ **physical**

4. Fill in each blank with ONE choice from the following list that is the best match:
BPSK, QPSK, FDMA, CDMA, TDM, QAM, amplitude, statistical, wave_division

- modulation method used in 802.11 that achieves a low data rate by sending a single bit 0 or 1 _____ **BPSK**
- modulation method used in 802.11 and LTE/5G networks to achieve higher data rates _____ **QAM**
- multiplexing method where sources take turns and a slot is unfilled if its source has no data _____ **TDM**
- multiplexing method where light waves are sent across optical fiber _____ **WDM (wave_division)**
- multiplexing methods used in 4G/LTE and 5G networks are based on _____ **FDMA**

5. For each property below, CIRCLE ONE transmission medium that best matches it.
TP=twisted pair, CC=coaxial cable, MM=multimode fiber, SM=singlemode fiber

- Uses a single wire and a metal shield: TP CC MM SM **CC**
- Cat 6 is a category of this wire type TP CC MM SM **TP**
- Used to achieve higher data rates over very long distances TP CC MM SM **SM**

6. For each of the following, CIRCLE the ONE item that matches.

- In HFC, fiber is used in the: feeder circuit trunk home **trunk**
- A set of modems used at the cable provider's side: CMTS tail-end modem DOCSIS **CMTS**
- Access technology that uses fiber from the provider to the customer: HFC FTTC FTTH **FTTH**
- Optical technology that can provide 100G and 400G data rates **OTN**

7. Circle ONE choice to indicate the correct answer:

- In phase shift modulation, to send 2 bits per shift, the total number of shifts is: 1 2 4 8 **4**
- If max and min frequencies of analog signal are 4 KHz and 1 KHz, its bandwidth in KHz is: 1 3 4 5 **3**
- If a system operates at 3000 baud and uses 4 signal levels, the bit rate in Kbps is: 3 6 12 48 **6**
- The number of signal levels in a 1000-baud system that sends at 3000 bits/s is: 1 2 4 8 **8**
- An 8-PSK mechanism has x times the data rate of a 2-PSK mechanism, where x= 1 2 3 4 **3**

8. Given the two bytes 10000000 (MSByte) and 10000001 (LSByte), assume the leftmost bit in each byte is MSbit and the rightmost bit in each byte is LSbit. Circle ONE of the 4 orders that is bit big endian and byte little endian, assuming the bits below are transmitted from left to right (i.e., leftmost bit first and rightmost bit last).
1. 10000001 10000000 2. 10000001 00000001 3. 10000000 10000001 4. 00000001 10000001 **1**

9. Generate a RAC parity matrix for a (12, 6) coding of the dataword 110001 (arrange dataword in 2 rows).
Assuming even parity: **1 1 0 0**
0 0 1 1
1 1 1 1

10. a) What two characteristics of a signal are varied in QAM? **amplitude and phase**
b) In 256QAM,

- how many points are in the constellation diagram? **256**
- how many bits does a single point represent? **8 since 2^8 =256**

11. Show the steps of each calculation below. (Exact answers shown within parenthesis are not needed).
a) If a transmission system has bandwidth B=8000 Hz and uses 4 values of voltage, find the maximum data rate in bits per second using the Nyquist formula $D=2B \log_2 K$, where D is the maximum data rate in bits per second and K is the number of values of voltage. **$D=2x8000x\log_2 4$ (=32,000 bits/sec)**
b) If a transmission system has bandwidth B=5000 Hz and an S/N ratio equivalent to 20 dB, find the maximum data rate in bits per second using the Shannon formula $C=B \log_2 (1+S/N)$, where the S/N ratio is $10 \log_{10}$ S/N in dB.
$10x\log_{10} S/N=20 \rightarrow \log_{10} S/N=2 \rightarrow S/N=100$
$C=5000x\log_2(1+100)=5000x\log_2 101$ (which is less than 35,000 bits/sec about 33291 bits/sec)
c) How many milliseconds does it take to send a 10 Megabyte file at 100 Mbps?
$((10x10^6x8)/(100x10^6))x10^3$ (800 ms; using 1 MB= 2^{20} bytes gives 838.9 ms)
d) A satellite is 1500 km above the earth's surface. How many milliseconds does it take for a signal to travel from the satellite to the user? The speed of light is $3x10^8$ meters/s. **$((1500x10^3)/(3x10^8))x10^3$ (=5 ms)**
e) The PCM voice standard uses 8000 samples/s. If 16 bits per sample are used, into how many levels is the range of the signal divided, and at what rate is data generated for a call? **16 bits have 2^{16} possible values, which is the number of levels. The data rate is: 8000 samples/s * 16 bits/sample (= 128, 000 bits/s = 128 kbps).**

12. Fill in the missing Java socket code. Choices: ServerSocket, 11111, 22222, Socket, "localhost", DatagramSocket, DatagramPacket, length, InetAddress,

_____ y = new _____ (_____)//TCP server listens on port 11111 for TCP client connections
ServerSocket, ServerSocket, 11111
_____x = y._____(); //TCP server connects to TCP client **Socket, accept**
_____ a = new _____ (_____, _____); //TCP client connects to localhost TCP server on port 11111
Socket, Socket, "localhost", 11111
_____ p = new _____ (); //UDP client defines a socket to connect to a UDP server **DatagramSocket, DatagramSocket**
_____ q = _____.getByName(_____); //UDP client gets IP address q of localhost Java server
InetAddress, InetAddress, "localhost"
_____ s = new _____(r, r._____, q ,_____); //UDP client sends packet byte[] r to localhost server at IP address q port 22222
DatagramPacket, DatagramPacket, length, 22222