Fall 2022 ECE 5600 Final Exam.
A#_____ Name_____

100 pts. This is a take-home exam. You may use textbook, lecture notes, HWs. Do not discuss any question on this exam or exchange information with anyone else.
Due: Wednesday, Dec 14, 5:00 pm. Please submit the final exam in canvas.

1. (4 pts) Match the network layer with its function.

Application Layer _____	a. provides end-to-end communication
Network Layer _____	b. converts data to the user's desired format
Physical Layer _____	c. user programs are part of this layer
Transport Layer _____	d. handles framing of data
Presentation Layer _____	e. deals with voltages, frequencies, radiation, etc.
Data-link Layer _____	f. handles routing through the subnet

2. (3 pts). Name two classical techniques used to multiplex multiple lower-bandwidth channels onto a single higher bandwidth line?

_____

_____

3. (3 pts) Assume a telephone line has a bandwidth of 3100Hz and a Shannon limit of 37kbps, what is the minimum possible signal-to-noise ratio? Express your answer in dB.

_____ dB.

4. (3 pts) How can 56kbps modems seemingly exceed the Shannon Limit?

_____

_____

5. (4 pts) How is the following bit string transmitted with (a) bit stuffing and (b) byte stuffing as it is done in PPP: 01111111 11100000 01111110 01111101.

(a) _____

(b) _____

6. (3 pts) What is the difference between pure and slotted ALOHA for channel allocation?

_____

_____

7. (3 pts) What frequency band does Bluetooth use, (b) How many different frequencies are used, and (c) How often do frequency hops occur?

(a) _____ (b) _____ (c) _____

8. (4 pts) What are the four primary "Quality of Service" parameters?

1) _____ 2) _____

3) _____ 4) _____.

9. (4 pts) A TCP packet with the FIN+ACK bits set contains 900 data bytes, has a sequence number = 75 and acknowledge number = 98. Assuming no error is detected, what sequence and acknowledge numbers should be returned in the acknowledgement packet?

Sequence _____ Acknowledge _____

10. (2 pts) Name the algorithm that coalesces small TCP segments while it waits for an acknowledgement of the previous segment. _____

11. (3pts). In the PSTN, what is the term for:

a) A connection from one office to another _____

b) A connection from the end office to the subscriber _____

c) An office that connects to cell phones via base stations _____

12. (4pts).Sketch the waveform obtained by encoding 01011011 with 4B/5B then NRZI. Assume an initial state of 0v.

13. (6 pts). Four stations (A..D) using Mok & Ward's binary countdown algorithm are currently assigned the values A=1, B=4, C=2, D=3 (0 is not used). If C is ready to transmit one frame and D is ready to transmit two frames, what are the address assignments after all three frames have been sent?

A = _____ B = _____ C = _____ D = _____

14. (6 pts). Using the CRC polynomial x^4+x+1 and an initial value of 0, compute the CRC for the bit sequence 10100101.

CRC = _____

15. (6 pts). 7-bit Hamming codewords are used to encode 4-bit values. After transmission over a noisy channel, the codeword 1011011 is received. What was the original 4-bit value?

16. (4 pts). What IP protocol numbers are used for each of the following?

a) _____ IP in IP

b) _____ TCP

c) _____ UDP

d) _____ ICMP

17. (15 pts) Use the following link state to answer problems.

A	
B	1
C	4
E	4

B	
A	1
C	3
D	2

C	
A	4
B	5
D	1

D	
B	2
C	3
E	1

E	
A	6
D	1
F	3

F	
E	3

a (5 pts).Draw a router diagram. Label each link with its length and each node with its router ID (A-F). If the two routers on either side of a link disagree on its length, take the mean (average) of the two.

b (5 pts). Use Dijkstra's Algorithm to find the shortest path from router A to all the other routers. In what order to the "nodes" (routers) become permanent.

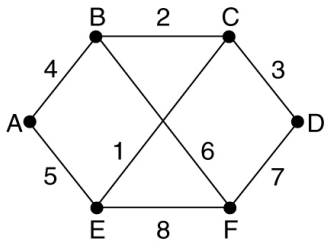
A, _____, _____, _____, _____, _____.

c (5 pts). Suppose each router is connected to a LAN and each LAN is assigned an IP address range as shown below. Router A has 4 lines. Lines 1, 2 and 3 connect to routers B, C and E respectively. Line number 4 is connected to A's LAN. What are A's (CDIR) routing table entries? (You will not need all the space provided.)

LAN IP Address Ranges	
A	130.0.0.0/19
B	130.0.32.0/21
C	130.0.40.0/21
D	130.0.48.0/20
E	130.0.64.0/20
F	130.0.90.0/20

A Routing Table	
Base IP address/mask	Line

18. (8 pts) Consider the subnet in the following. Distance vector routing is used, and the following vectors have just come in to router C: from B: (5, 0, 8, 12, 6, 2); from D: (16, 12, 6, 0, 9, 10); and from E: (7, 6, 3, 9, 0, 4). The measured delays to B, D, and E, are 6, 3, and 5, respectively. What is C's new routing table? Give both the outgoing line to use and the expected delay.



19. (5 pts). Provide the well-known port number for each of the following application layer protocols:

http: _____	ssh: _____
telnet: _____	https: _____
dns: _____	tftp: _____
pop3: _____	bootp (server): _____
echo: _____	bootp (client): _____

20. (5 pts). A Diffie-Hellman key exchange uses p = 43 and g = 13. If one side chooses a random number a of 7 and the other side sends a key exchange message which contains the number 24, what is the secret key?

21. (5 pts) Captain Picard's public RSA key is (e=29, n=91). What is his private key? (Note: you will have to factor 91 to get it). To verify that you have the right key, show that the decryption D(61) = 3.