CMSC 417 Computer Networks **Fall 2021**

Final Exam

Open book and notes *Saturday, December 18th*

⊕ *Do not forget to write your name on the first page. Initial each subsequent page.*
⊕ *Be* **neat** *and* **precise**. **I will not grade answers I cannot read.**
⊕ *You should draw simple figures if you think it will make your answers clearer.*
⊕ *Good luck and remember, brevity is the soul of wit*

- All problems are mandatory
- I cannot stress this point enough: **Be precise**. If you have written something incorrect along with the correct answer, you should **not** expect to get all the points. I will grade based upon what you **wrote**, not what you **meant**.
- Maximum possible points: 50 + bonus.

Name: _____

Problem	Points
1	
2	
3	
4	
5	
Total	

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	2	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384	32768	65536

1. Nomenclature

   (a) Describe the following terms: (2 points each)

   - Exposed Node

   - Subnet

   - MX Resource Record

   - Swarm (in BitTorrent)

   - Genesis Block

2. Network and Transport

(a) How is CIDR next hop lookup different from original IP? (2 points)

(b) Why is the TCP TIME-WAIT state required? Be precise. (3 points)

(c) Suppose a process `bind`s to port 2323, and services TCP connections. The process exits, but upon re-start, the `bind` fails with "Error: Address already in use" (EADDRINUSE). Why does this happen? (3 points)

(d) Suppose you want the `bind` to succeed in the example above. What can do you? (2 points)

3. MAC protocols, Error Detection

   (a) What is the minimum Ethernet (IEEE 802.3) payload size? (1 point)

   (b) What would be the maximum segment size in Ethernet if the minimum payload size was 0 bytes? Show your work. (3 points)

   (c) `00 10 01 11 11 00` is received. The original was encoded using Hamming codes as discussed in class. Is this message correct? If not, which bit is in error? Show your work. (3 points)

(d) Assume a CRC polynomial $x^3 + x + 1$. What should be transmitted for message `00100100`. Show your work. (2 points)

4. Applications

   (a) How many simultaneous TCP connections can a NAPT device with a single public IP address theoretically sustain? Explain your assumptions and show your work. You should provide an algebraic expression, and not just an integer. (2 points)

   (b) A Bitcoin client has received valid blocks including and up to block 10001. It thereafter receives a different block 10000, which is consistent with blocks 0-9999 but conflicts with the previous block 10000. How should a legal client treat this new block? Explain your assumptions. (3 points)

(c) We want to implement support for a DHT-based *tracker* for BitTorrent. Assume we have a DHT that provides operations such as Get(Key) $\rightarrow$ Value and Append(Key, Value). What should change in the torrent file to support this? (2 points)

(d) Show one way such a tracker could be used to initiate downloads in BitTorrent. (3 points)

5. Applications

(a) Write the polynomial corresponding to a r-bit burst error starting at index i in CRC. (2 points)

(b) Consider the function $\overline{Q}$(P) defined over CRC polynomials. If $P = x^b + \ldots + x^a$, $\overline{Q}$(P) = b - a, i.e. $\overline{Q}$(P) is defined as the difference in degree between the highest degree and lowest degree term in P.

- Suppose our CRC polynomial is G(x) $= x^k + \ldots + 1$. What is $\overline{Q}$(G)? (1 point)

- Consider a k bit burst error. What is $\overline{Q}$(E)? (1 point)

- Suppose $P = x^b + \ldots + x^a$. Show that $\overline{Q}$(P) = $\overline{Q}$(P*x^n). (2 points).

- We will prove that CRC can detect all k bit burst errors, using the $\overline{Q}(\cdot)$ function. Complete the following proof by contradiction.

  Suppose G|E. By definition, $\exists$ C such that E = GC. Show that $\overline{Q}(\text{GC}) \neq \overline{Q}(\text{E})$. (4 points)