CMSC 417 Computer Networks **Fall 2021**

Second Third-Term Exam

Open book and notes; In class *Thursday, Nov. 11th*

⊕ *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)

   - Sender Policy Framework (SPF)

   - Name Server

   - DNS Zone

   - DKIM (the protocol)

   - DNS PTR Record

2. Transport/DNS

(a) Assume that a NAPT local realm has only one host. How many concurrent TCP connections can the NAPT device make to 4.2.2.1:80 (in the global/foreign realm)? How does this number change if the number of local realm hosts increases to 2? (1 + 2 points)

(b) What service(s), beyond checksumming, does UDP provide over IP? (1 point)

(c) What is the maximum end-to-end throughput you could achieve on a 1 Gbps, 250ms RTT link, with send window-size $\leq$ 40 maximum-sized segments, segment size $\leq$ 1250 bytes. Show your work. (3 points)

(d) What is the primary benefit of storing a name vs. an address in the RDATA part of a NS record? (3 points)

3. TCP

(a) What is TCP Fast Retransmit? (2 points)

(b) What socket calls enable TCP passive open and active open? (2 points)

(c) What is the maximum value of TCP's window scale? Why? (1+2 points)

(d) (Why) is the the TCP `TIME WAIT` required? Are there cases when both TCP end-points enter `TIME-WAIT`? (2+1 points)

4. DNS/Application-Layer

   (a) What is a FQDN? Explain with an example. (1+1 points)

   (b) You administer the `umd.edu.` domain, and want to delegate the `a.umd.edu.` subdomain. Explain what records you would add to your zone to enable this. (2 points)

   (c) Describe three advantages of QUIC over HTTP/1.1. (3 points)

   (d) What additional benefit does SPF provide over reverse DNS lookups of the HELO/EHLO domain? (3 points)

5. Code

(a) Find as many errors in the following code as you can. This code is based on the amessage.proto example on the protobuf-c wiki pages. (5 points)

```
# amessage.proto
message AMessage {
  required int32 a=1;
  optional int32 b=2;
}
```

Code with errors follows:

```
#include <stdio.h>
#include <stdlib.h>
#include "amessage.pb-c.h"

int main (int argc, char **argv)
{
  AMessage msg;                  // amessage structure
  void *buf;                     // Buffer to store serialized data

  msg.a = atoi(argv[0]);
  msg.b = atoi(argv[1]);

  buf = malloc(sizeof(msg));
  amessage__pack(&msg,buf);

  fwrite(buf, sizeof(buf),1,stdout); // Write to stdout to allow direct command line piping

  free(buf); // Free the allocated serialized buffer
  return 0;
}
```

(b) Function `dispatch` has the following prototype:

```
void dispatch(int *sd_set,  int n_sd,  void (*net_reader)(int),
void (*ui_updater)(void));
```

`dispatch` takes in an array of socket descriptors (`sd-set`) of length `n-sd`, and two functions `net-reader` and `ui-updater`. Provide pseudocode of `dispatch` that invokes `net-reader` for every descriptor that is ready to read, and invokes `ui-updater` approximately every 1/24th of a second. `dispatch` should continue this read/UI-update cycle forever. Do not use multiple processes, threads or signals (e.g., SIGALRM).

Note: this problem asks you to provide **pseudocode**, not code that will compile. You should base your pseudocode on system calls you have learned/used, such as `select` or `poll`, but you don't have to get the syntax/specifics exactly correct. Your solution will be graded on correctness as well as cleanliness of design. (5 points)