Problem 1

Suppose you have a new computer just set up. `dig` is one of the most useful DNS lookup tool. You can check out the manual of `dig` at `http://linux.die.net/man/1/dig`. A typical invocation of `dig` looks like: `dig @server name type`.

Suppose that on April 19, 2017 at 15:35:21, you have issued "`dig google.com a`" to get an IPv4 address for `google.com` domain from your caching resolver and got the following result: (If a user just types "dig google.com" the default is type=A)

```
; <<>> DiG 9.8.3-P1 <<>> google.com
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 17779
;; flags: qr rd ra; QUERY: 1, ANSWER: 1, AUTHORITY: 4, ADDITIONAL: 4

;; QUESTION SECTION:
;google.com.                IN     A

;; ANSWER SECTION:
google.com.           239    IN     A      172.217.4.142

;; AUTHORITY SECTION:
google.com.           55414  IN     NS     ns4.google.com.
google.com.           55414  IN     NS     ns2.google.com.
google.com.           55414  IN     NS     ns1.google.com.
google.com.           55414  IN     NS     ns3.google.com.

;; ADDITIONAL SECTION:
ns1.google.com.       145521 IN     A      216.239.32.10
ns2.google.com.       215983 IN     A      216.239.34.10
ns3.google.com.       215983 IN     A      216.239.36.10
ns4.google.com.       215983 IN     A      216.239.38.10

;; Query time: 81 msec
;; SERVER: 128.97.128.1#53(128.97.128.1)
;; WHEN: Wed Apr 19 15:35:21 2017
;; MSG SIZE rcvd: 180
```

1. What is the discovered IPv4 address of `google.com` domain?
2. If you issue the same command 1 minute later, how would "ANSWER SECTION" look like?
3. When would be the earliest (absolute) time the caching resolver would contact one of the `google.com` name servers again? (for issuing the same command "dig google.com a")
4. When would be the earliest (absolute) time the caching resolver would contact one of the `.com` name servers? (for issuing the same command "dig google.com a")

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1. 172.217.4.142

2. google.com. 116 IN A 172.217.5.78
google.com. 89 IN A 172.217.5.78
IP address is the same while the time is decreasing.

3.55414

4.215983

Problem 2

Suppose that you walked into Boelter Hall and get connected to `CSD` WiFi network, which automatically gave you IP address of the local caching resolver. However, initially, it doesn't allow you to do anything unless you type your username and password in a popup window (or if you try to go to any website in your browser).

1. Explain a mechanism of how does the "`CSD`" network achieve this / which features of DNS/HTTP make it possible.

CSD redirects all unauthorized DNS queries to the captive portal, a specific server which makes the user log in, after which the CSD network will direct DNS queries to the requested servers.

Problem 3

Same context as Problem 2. After you successfully logged in, you can start using the Internet. Suppose the caching resolver has just rebooted and its cache is completely empty; RTT between your computer and the caching resolver is $10ms$ and RTT between the caching resolver and any authoritative name server is $100ms$; all responses have TTL 12 hours.

1. If you try to go to `ucla.edu`, what would be minimum amount of time you will need to wait before your web browser will be able to initiate connect to the UCLA's web server?
2. What would be the time, if a minute later you will decide to go to `ccle.ucla.edu`?
3. What would be the time, if another minute later you will decide to go to `piazza.com`?
4. What would be the time, if another minute later you will decide to go to `gradescope.com`?

1. 100 + 100 + 10 = 210 ms
2. 100 + 10 = 110 ms
3. 100 + 100 + 10 = 210 ms
4. 100 + 10 = 110 ms

Problem 4

How does SMTP mark the end of a message body? How about HTTP? Can HTTP use the same method as SMTP to mark the end of a message body? Explain.

SMTP uses a line containing only a period to mark the end of a message body. HTTP uses Content-Length header field to indicate the length of a message body. No, HTTP cannot use the method used by SMTP, because HTTP message could be binary data, whereas in SMTP, the message body must be in 7-bit ASCII format.

Problem 5

Consider the following environment with a local DNS caching resolver and a set of authoritative DNS name servers.

Assume that initially,

- the caching resolver cache is empty,
- TTL values for all records is 1 hour,
- RTT between stub resolvers (hosts A, B, and C) and the caching resolver is 20 ms,
- RTT between the caching resolver and any of the authoritative name servers is 150 ms,
- There are no packet losses,
- All processing delays are 0 ms

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1. At T=0 min, Host-A sends a query for A record for amazon.com, and after receiving the answer sends a query for A record for www.amazon.com. How long did it take to receive all the answers?

2. At T=40 min, Host-B sends a query for MX record for google.com that returns

```
google.com.           3600   IN     MX     10 primary.google.com.
google.com.           3600   IN     MX     30 backup.google.com.
primary.google.com.   3600   IN     A      74.125.28.27
backup.google.com.    3600   IN     A      173.194.211.27
```

   (Similar to NS records, the DNS server may return glue A/AAAA records in addition to the requested MX records.) How long did it take to get the answer?

3. At T=70 min, Host-C sends a query for AAAA (IPv6) record for mail.google.com, following at T=75 mins with a query for AAAA (IPv6) record for hangout.google.com. How long did it take for Host-C to receive each of the answers (i.e., relative to T=70min for the first, and relative to T=75 mins for the second)?

4. List DNS records that the caching resolver has at T=90 minutes

1.It first query the caching, root name server, .com name server and amazon.com name server. The time is : 20 + 150 * 3 = 470 ms. Then it will query the caching and amazon.com name server. It will be 20 + 150 = 170 ms. Total time is 640 ms.

2.It will query the caching resolver, the .com name server and google.con name server. The total time is 20 + 150*2 = 320 ms.

3.Both of them need to query the caching and google.com name server. Thus, it will take 20 + 150 = 170 ms.

4.The records include google.com/MX, primary google.com/A. backup.google.com/A. google.com/NS which are got at the T = 40 min and 10 min remaining. The mail.google.com/AAAA and hangout.google.com/AAAA which are got at T = 70min and T= 75 min and remain 40 mins and 45 mins.