American University of Beirut

Department of Electrical and Computer Engineering

EECE 350/450 Computer Networks — Final Exam - Closed Book

May 24, 2013 — **120 minutes**

ALL QUESTIONS ARE GRADED EQUALLY – PENALTY IS FOUR TO ONE

NAME_____ signature here

SIGN: ***I HAVE NEITHER GIVEN NOR RECEIVED AID ON THIS EXAM***	

1.
I. An ARP request is sent with a source Ethernet MAC address of FF:FF:FF:FF:FF:FF
II. There can be up to 40 bytes of options in the IP header.
a) True, True b) True, False c) False, True d) False, False

2.
I. UDP provides reliability while TCP provides congestion control.
II. DHCP allocates Ethernet addresses for a certain period of time.
a) True, True b) True, False c) False, True d) False, False

3.
I. When a router forwards an IP datagram, it must re-compute the IP checksum.
II. Routers reassemble IP fragments if the total fits in the next hop MTU.
a) True, True b) True, False c) False, True d) False, False

4.
I. OSPF supports hierarchical routing.
II. RIP must be used between routers in different autonomous systems.
a) True, True b) True, False c) False, True d) False, False

5.
I. OSPF is a policy-based routing protocol.
II. BGP is a link-state routing protocol.
a) True, True b) True, False c) False, True d) False, False

6.
I. It is impossible to implement a version of traceroute with IPv6.
II. IPv6 addresses are 48-bit long.
a) True, True b) True, False c) False, True d) False, False

7. Which address appears in the IP datagram when we issue the command: *ping localhost* ?
a) 10.0.0.1 b) 127.0.0.0 c) 127.0.0.1 d) 10.0.0.0 e) none of the above

8. Which of the following protocols is *not* involved when sending an email message to root@apple.com?
a) TCP
b) UDP
c) SMTP
d) DNS
e) None of the above

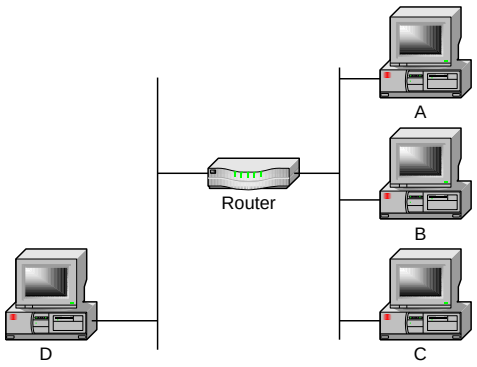
9. A class C network uses a subnet mask of 255.255.255.248. What is the maximum number of assignable IP addresses per subnet?
a) 5 b) 6 c) 7 d) 8 e) none of the above

10. Network 145.20.0.0/16 ’s system administrator decided to use the 3 most significant bits of the host number as the subnet number. What is the corresponding subnet mask?
a) 255.255.0.0 b) 255.224.0.0 c) 255.255.255.224 d) 255.255.224.0 e) none of the above

11. In the TCP round-trip time, RTT is currently estimated at 500 msec and the following ACKs come in after 350, 670, and 250 msec, respectively. What is the new RTT estimate (in msec)? Use alpha = 0.2.
a) 399 b) 473 c) 458 d) 322 e) none of the above

12. In a TCP connection, the receiver’s advertised window is 64 KBytes over a 10 Mbps point-to-point link that has a 5 msec RTT. What is the maximum throughput achievable (in Mbps)?
a) 26.2 b) 52.4 c) 209.7 d) 104.8 e) none of the above

Consider the network shown consisting of 4 hosts and 1 router. Denote the router interface on the network with hosts A, B, C as R1, and the other interface as R2.



13. Assume that the ARP tables at the hosts and the router are initially empty. What entry is entered in the ARP table of host **A** *after* **A** successfully sends a message to host **D**? The format is [IP address(host) , MAC address(host)]
a) [IP(R1), MAC(D)]
b) [IP(R1), MAC(R1)]
c) [IP(D), MAC(R1)]
d) [IP(D), MAC(D)]
e) none of the above

Consider a home LAN connected to an ISP through a NAT device (in combination with a modem). The ISP has assigned the owner of the network a permanent IP address, say 213.10.169.34. A process *A* on one host in the home network with private IP address 10.0.0.2 sets up a TCP connection from port 23000 to a process *B* on a host having (public) address 192.31.231.80, and which is listening to port 80. There are no routers on the home LAN other than the NAT device. The IP address of the interface of the NAT device on the home LAN is 10.0.0.1.

14. The source IP address of datagrams leaving the NAT device towards the home LAN, and belonging to the TCP connection is
a) 10.0.0.1 b) 10.0.0.2 c) 213.10.169.34 d) 192.31.231.80 e) none of the above

15. The source IP address of datagrams leaving the NAT device towards the Internet, and belonging to the TCP connection, is:
a) 10.0.0.1 b) 10.0.0.2 c) 213.10.169.34 d) 192.31.231.80 e) none of the above

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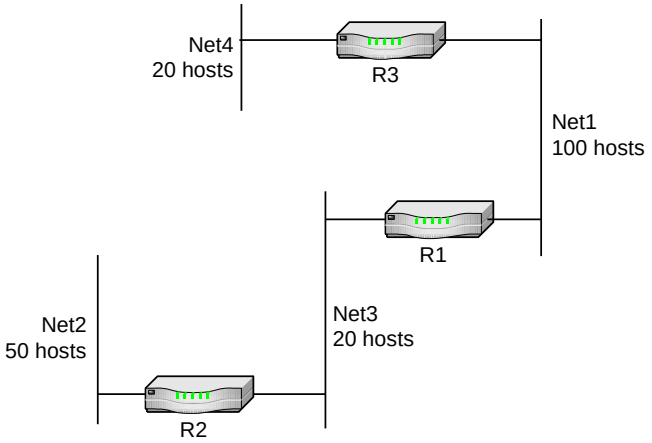
Consider the network shown. You have a class C network number (192.168.1.0/24) that you have to subnet in order to assign IP addresses to all hosts and routers in the network. You will start assigning IP addresses on Net1, then Net2, Net3, and finally Net4. The router interfaces always get the smallest IP addresses in the subnet. If two routers are attached to one network, the routers get the addresses in the same order of their number (example: on Net1, the interface of R*1* gets the smallest IP address, then the interface of R*3* gets the next IP address).



16. What is the (sub-)network address of Net2?
a) 192.168.1.128 b) 192.168.1.32 c) 192.168.1.0 d) 192.168.1.64 e) none of the above

17. What is the IP address of the interface of R2 on Net3?
a) 192.168.1.129 b) 192.168.1.194 c) 192.168.1.193 d) 192.168.1.1 e) none of the above

18. The following are two entries in R3's routing table. The sum of the missing two numbers is:

destination	next hop
192.168.1.**X**/27	Direct
192.168.1.**Y**/25	Direct

a) X + Y = 192
b) X + Y = 160
c) X + Y = 224
d) X + Y = 240
e) none of the above

19. What is the broadcast address on Net3?
a) 192.168.1.127 b) 192.168.1.223 c) 192.168.1.255 d) 192.168.1.191 e) none of the above

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20. The New University of Lovely Lebanon (NULL) is connected to the Internet using an access link with a bitrate of 10 Mbps. The active users on the internal network (a Fast Ethernet, with negligible delay) generate requests for objects from the web at the rate of 100 per second. The object size is 100,000 bits, on average. What is the utilization of the Internet link of NULL?
a) 100% b) 50% c) 70% d) 10% e) none of the above

21. The delay on a link with utilization u (u is between 0 and 1) is given by $D_0/(1 - u)$ where D_0 is the "unloaded" delay. What is the delay that the users on the NULL network will experience while downloading objects from the web, assuming that D_0 is 250 msec?
a) 100 msec b) 500 msec c) 1000 msec d) 2000 msec e) none of the above

22. The users on the NULL network started to complain about the long delays, and asked the administration to upgrade its Internet link. To what bitrate should the NULL administration upgrade its link to get delays of at most 500 msec, due to the access link only?
a) 20 Mbps b) 50 Mbps c) 40 Mbps d) 100 Mbps e) none of the above

23. With the upgraded link, the access link delay is now 500 msec. There is an additional delay due to fetching the objects from the origin web server. What is the total delay in this case, given that the average delay to fetch an object from the origin server is 1.5 sec?
a) 10 s b) 1.5 s c) 0.1 s d) 2 s e) none of the above

24. A network engineer proposed to the NULL administration to install a caching proxy server on the internal LAN (she also proposed changing the name of the university to Best University of Lovely Lebanon – BULL). The average hit rate of the cache is 45%, i.e. 45% of the objects that users request are available locally on the caching proxy server. There is negligible delay in fetching objects from the cache. The network engineer proposed further to save money by going back to the 10 Mbps access link. What is the delay due to the access link in this case?
a) 0.25 s b) 0.556 s c) 1.5 s d) 1.56 s e) none of the above

25. What is the average delay that the users on the FULL network will experience with the cache in place, and using the 10 Mbps link?
a) 1.35 s b) 1.5 s c) 1.13 s d) 1.56 s e) none of the above

Suppose a TCP segment that contains 1460 bytes of TCP data and 20 bytes of TCP header is passed from the transport layer to IP for delivery across three networks of the Internet (i.e. from the source host through router1, then router2, and then to a destination host). The first network uses frames with an MTU of 1500 bytes; the second network uses frames with an MTU of 800 bytes; and the third network uses frames with an MTU of 500 bytes. Note that the MTU is the size of the *data* portion of the layer-2 frame. Refer to the last page for header formats, if needed.

Assume in the following that IP datagrams are neither lost nor re-ordered.

26. What is the *Length* field (in decimal) of the last IP datagram fragment received at the destination?
a) 244 b) 480 c) 500 d) 224 e) none of the above

27. What is the *Length* field (in decimal) of the last IP datagram as it is received at the second router?
a) 796 b) 724 c) 704 d) 776 e) none of the above

28. What is the *Fragment Offset* field (in decimal) of the last IP fragment received at the destination?
a) 143 b) 151 c) 155 d) 157 e) none of the above

29. What is the *Fragment Offset* field (in decimal) of the last IP datagram as it is received at the second router?
a) 91 b) 93 c) 95 d) 97 e) none of the above

The following hexadecimal numbers represent an IP datagram. The bytes are ordered from left to right, top to bottom.
Refer to the last page for header formats.

```
45 00 00 3a f0 72 20 00 3c 06 d0 7c c0 a8 c6 40 c0 a8
c6 9e 00 17 09 5b 07 28 08 48 01 32 a4 2c 50 16 0f de
be 2a 00 00 6c 6f 67 69 6e 3a 20 0d 0a 6c 6f 67 69 6e
3a 5b 6c 20
```

30. Is the IP datagram complete (i.e. does the given data show the full IP datagram)?
a) Yes b) No

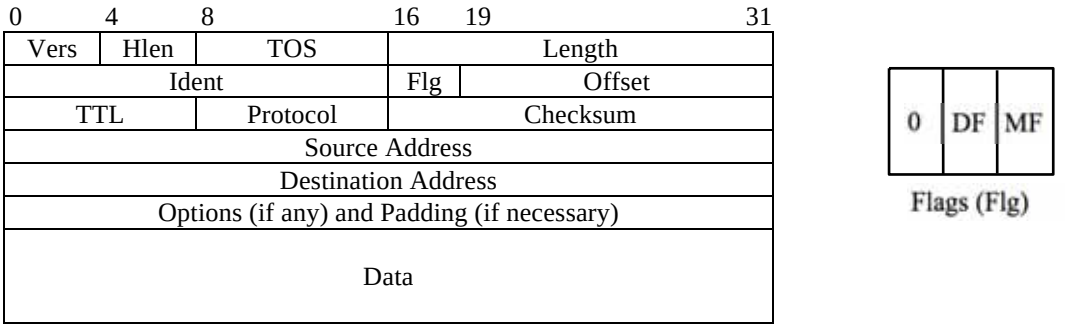
31. Is the IP datagram a fragment?
a) Yes b) No

32. What is the source IP address in dotted decimal notation?
a) 192.168.198.60
b) 192.168.198.128
c) 192.168.198.132
d) 192.168.198.64
e) none of the above

33. Is the ACK field in TCP valid?
a) Yes b) No

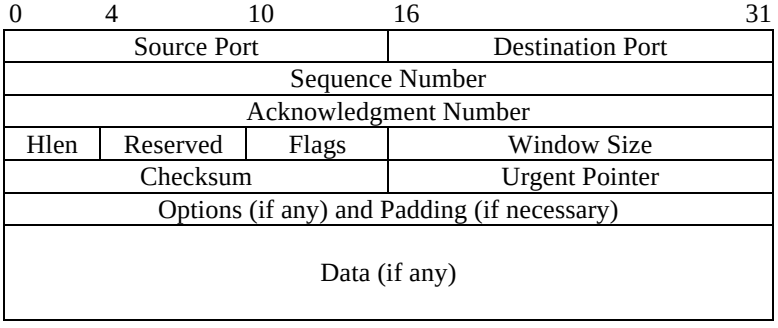
34. For this IP datagram, the initial TTL was set to 64 (decimal). How many routers has it traversed?
a) 1 b) 2 c) 3 d) 4 e) none of the above

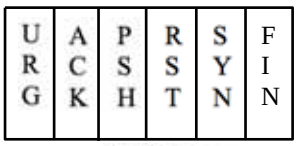
IP Datagram



Flags (Flg)

TCP Segment





TCP Flags