

CS513/EE506/CS4514 Intro to Local and Wide Area Networks  
Craig E. Wills  
Given: Wednesday, July 19, 2006

WPI, Summer 2006  
Final Exam (100 pts)

NAME: \_\_\_\_\_

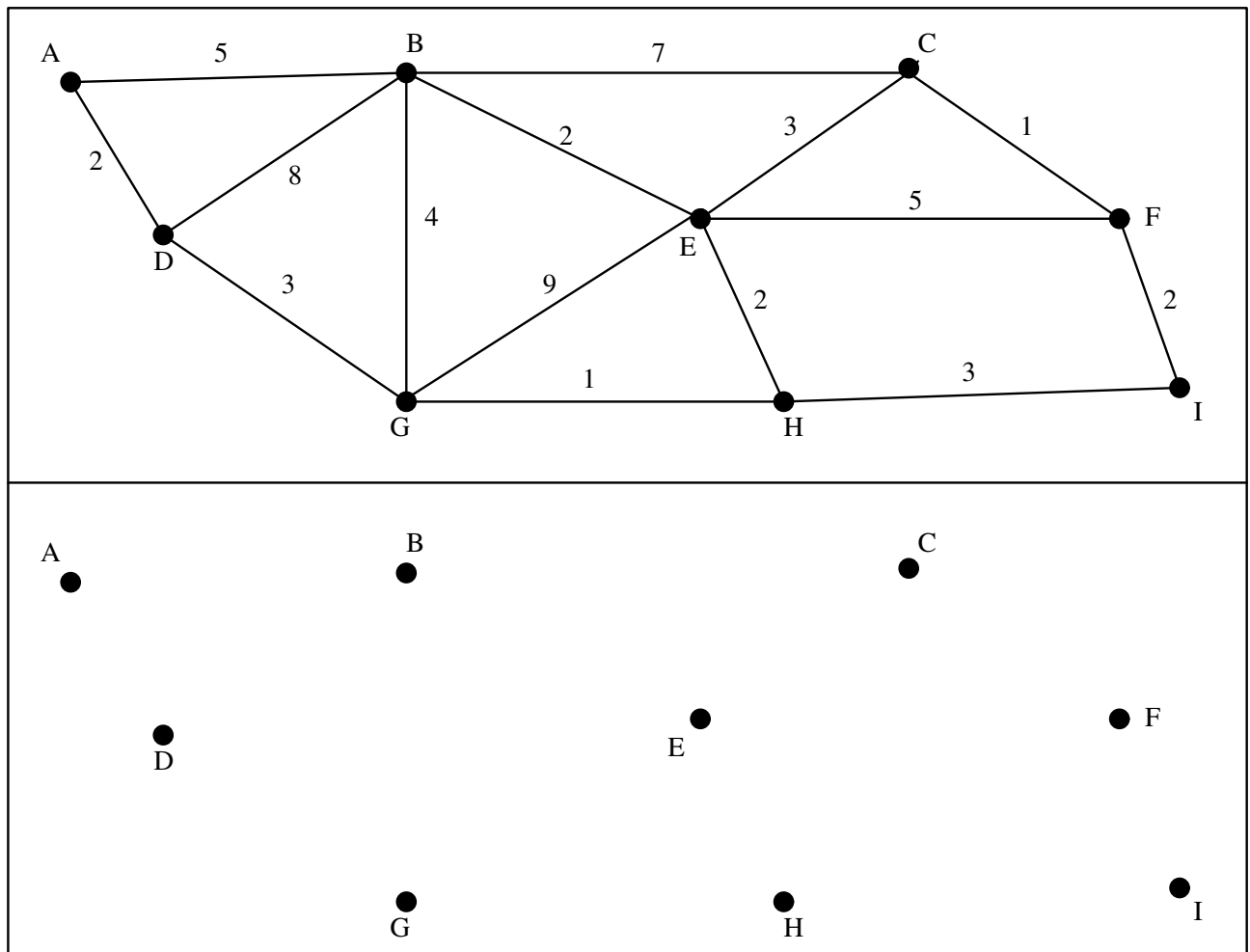
This is a closed book (and notes) examination. Answer all questions on the exam itself. Take the number of points assigned to each problem and the amount of space provided for your answer as a measure of the length and difficulty of the expected solution. The exam totals 100 points.

*Potentially* useful formulas:

- Nyquist rule for a noiseless channel:  
max data rate =  $2H \log_2 V$  bps where  $H$  is the bandwidth and  $V$  is the number of states encoded.
- Shannon's theorem for channels with noise:  
max data rate =  $H \log_2(1 + S/N)$  bps where noise is measured in decibels (db) and  $\text{db} = 10 \log_{10} S/N$

SCORE: \_\_\_\_\_

1. (18 points) This entire question (parts a-d) refer to the network of routers shown in the following figure.



- (a) (5 points) Compute and show the sink tree for router E in the space given in the figure. The numbers shown for each link indicate the delay (bidirectional) for that line.
- (b) (3 points) If router E receives a packet sent from packet A destined for router F, what does router E do with this packet?

(c) (5 points) Assume that the link between routers G and H is cut resulting in an infinite delay on the line between these routers. Using a *link-state routing algorithm*, how does router E find out about this change and how does it update its routing tables accordingly?

(d) (5 points) Assume that the link between routers G and H is cut resulting in an infinite delay on the line between these routers. Using a *distance-vector routing algorithm*, how does router E find out about this change and how does it update its routing tables accordingly?

2. (10 points) Backward learning.

(a) What is the key idea in backward learning that makes it appealing?

(b) What is its primary disadvantage?

(c) Given an example where it is used.



5. (8 points) Remote Procedure Call (RPC) is a mechanism that provides procedure-call semantics.

(a) What layer is immediately *below* RPC in the OSI protocol stack?

(b) Does RPC require the protocol at this layer below to provide any particular delivery semantics? Briefly explain.

6. (12 points) Network addressing.

(a) What is the primary purpose of ARP in terms of network addressing?

(b) What is the primary purpose of DHCP in terms of network addressing?

7. (6 points) The protocol field in the IP header is used to indicate the type of data that the datagram is carrying, such as TCP or UDP. This use of the protocol field seems to violate the notion of layer abstraction where one layer does not know any information about layers above it. Indicate why such a field is necessary for the suite of Internet protocols.

8. (8 points) Autonomous Systems (ASes) were not part of the original Internet, but are used today.

(a) What are ASes?

(b) How do IGPs and EGPs relate to ASes?

9. (8 points) Access points (APs) are typically used to connect a wireless LAN to a wired LAN infrastructure. The 802.11 protocol used to communicate between a wireless node and an AP uses Request-to-Send (RTS) and Clear-to-Send (CTS) frames as well as acknowledgments of frames.

(a) Why does the 802.11 protocol use these frames when the 802.3 (Ethernet) protocol does not?

(b) TCP was developed and deployed in a wired network, but now is also being used for wireless networks. What assumption is made in TCP that may not be the case for a wireless network?

10. (10 points) Assume machines machine A wants to transfer a large file to machine B using either UDP or TCP. In the case of UDP, the transfer is done from machine A by sending UDP packets one after another until no more data needs to be sent. Regardless of which transport protocol is used, all IP packets sent by A are reliably delivered to B without any being lost.

(a) Assuming A and B are on the same local area network, will there be any difference in performance between using TCP or UDP as the transport protocol? Explain.

(b) Assuming A and B are at different sites on the Internet, will there be any difference in performance between using TCP or UDP as the transport protocol? Explain.