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**ENEE 426**  
**Midterm Exam, Spring 2008**  
Thursday, March 13

**Multiple Choice** (2 points each)

Circle the letter of the response that best answers the question.

1. Which of the following does latency most directly affect?
  - a. The rate at which data can be delivered
  - b. The level of interactivity between those communicating
  - c. The total amount of data that can be delivered
  - d. The quality of the data that can be delivered
2. Circuit-switched networks are best suited for which of the following?
  - a. Bursty communications
  - b. Dynamically changing networks
  - c. Mobile broadband communications
  - d. Low-latency applications
3. Which of the following groups standardizes network, transport, and application-layer protocols?
  - a. Internet Engineering Task Force (IETF)
  - b. Institute for Electronics and Electrical Engineers (IEEE)
  - c. 3<sup>rd</sup> Generation Partnership Project (3GPP)
  - d. 3<sup>rd</sup> Generation Partnership Project 2 (3GPP2)
4. Which of the following protocols is responsible for global addressing on the Internet?
  - a. Ethernet
  - b. Internet Protocol (IP)
  - c. User Datagram Protocol (UDP)
  - d. Transport Control Protocol (TCP)
5. Which of the following is NOT a property of TCP?
  - a. In-order delivery of packets
  - b. Guaranteed delivery of packets
  - c. Flow control
  - d. Local network addressing
6. At which layer of the OSI network stack do switches and bridges operate?
  - a. Physical
  - b. Data Link / MAC
  - c. Network
  - d. Transport
7. What is the *minimum* class of cable required to support 100 Mbps Ethernet?
  - a. Category 3
  - b. Category 5
  - c. Category 5e
  - d. Category 6

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8. Which of the following types of fiber-optic cabling is well suited for use with Light Emitting Diodes (LEDs)?
  - a. Coaxial
  - b. Shielded
  - c. Single-Mode
  - d. Multimode
9. Which of the following is not a supported 802.11 topology according to current, published standards?
  - a. Ad-Hoc
  - b. Infrastructure
  - c. Mesh
  - d. Wireless Distribution System
10. Which of the following is NOT a 3G mobile phone standard?
  - a. Universal Mobile Telecommunications System (UMTS)
  - b. Mobile WiMAX (IEEE 802.16e)
  - c. CDMA 2000 Evolution-Data Only (EV-DO)
  - d. Wireless Application Protocol (WAP)

**Short Answer** (4 points each)

Answer each of the questions in 2-3 sentences.

11. How does the “hourglass design” of the Internet protocol stack promote innovation?

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12. Describe the benefit in twisting pairs of copper cables together in twisted pair cables.

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13. Why would distributed multiple access be more suitable than infrastructure for disaster-recovery and military environments?

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14. Describe the hidden terminal problem and how RTS/CTS messages mitigate its effects.

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15. Why do TCP/FTP and UDP/CBR flows not share bandwidth evenly?

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16. Describe how frequency re-use is accomplished in cellular networks.

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Quantitative Problems (8 points each)

17. Compute the maximum achievable rate for a wireless communications system that utilizes two channels simultaneously. The ambient noise power is  $10 \mu\text{W}$ . On the first channel, the communications bandwidth is 10 MHz, and the signal power is  $30 \mu\text{W}$ . On the second channel, the communications bandwidth is 5 MHz and the signal power is  $70 \mu\text{W}$ .

18. Compute the bandwidth-delay product for a 40-kilometer link of copper cabling that transmits one of 8 distinct voltages every 50 microseconds.

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19. Draw the NRZI encoding of the following bit stream: 0 1 1 0 0 1 1 1 1 0 0 1

20. Compute the data rate for a copper cabled link that transmits one of 4 distinct voltages each microsecond using 4B/5B encoding.

21. Complete the 2-dimensional parity for the following block of data. Assume even parity.

<b>1</b>	<b>1</b>	<b>0</b>	<b>1</b>	
<b>1</b>	<b>0</b>	<b>1</b>	<b>0</b>	
<b>0</b>	<b>1</b>	<b>0</b>	<b>0</b>	
<b>1</b>	<b>1</b>	<b>0</b>	<b>1</b>	

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22. An extension to Shannon's equation for capacity is  $C = D * B * \log_2(1 + SNR)$  where  $D$  is the signal's *duty cycle*, or ratio of time that it has access to the channel. Use this to prove that the achievable per-user capacity is equal for two networks of  $N$  users, where one network is FDMA and the other is TDMA. Assume each user has an equal share of the network resources and all users have the same  $SNR$ .

23. Compute the average per-packet latency through a switch where packets arrive according to a Poisson process with average rate of 100 packets per second, and exponentially-distributed sizes with mean length of 100 bits. The rate of the outbound link is 20 kbps.