

- **READ THESE INSTRUCTIONS CAREFULLY.**
- Before you begin, **write your USC ID.**
- The exam is closed book and closed notes, all ELECTRONICS should be put away
- Answer the questions *only* in the spaces provided on the question sheets. If you run out of room for an answer, your answer is probably incorrect.
- Your answers do not need to be complete, grammatically correct sentences.
- For some multiple-choice questions, **more than one choice may be correct.** You will receive credit for partial answers.
- An incorrect answer to a multiple-choice question will result in a deduction of 50% of the points allotted to that question. So, for example, if a multiple-choice question worth 1 point has 2 correct answers and one of your answers is wrong, you will get 0.5 for the correct answer and -0.25 for the incorrect answer, resulting in a total of 0.25.

USC ID: \_\_\_\_\_

## 1. Multiple Choice: Select all that apply

(a) (4 points) Packet switching compared to circuit switching

- ☐ has a higher connection setup time
- ☐ offers predictable quality of service
- ✓ **leverages the gap between the average and peak traffic rates**
- ✓ **can tolerate router failures**
- ☐ is suitable for telephone service

(b) (4 points) The internet has failed to provide

- ☐ connectivity of heterogenous networks
- ☐ support for multiple types of delivery services
- ✓ **global resource management and accountability**
- ☐ easy end host attachment
- ☐ robustness to router failures
- ✓ **secure end to end communication**

## 2. True or False, explain

(a) (3 points) The path capacity is the maximum bandwidth of any link on the path.

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**Solution:** False (one point) (two points) The end to end path capacity is the constrained by the smallest link bandwidth on the path.

(b) (3 points) The end to end principle is a set of directives to guarantee the network quality of the path.

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**Solution:** False (one point) (two points) The end to end principle states that application-specific functions should reside in the end hosts of a network rather than in intermediary routers. Hence it makes not guarantees about the path taken

(c) (3 points) Circuit switching efficiency is high in large file transfers across the network.

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**Solution:** True (one point) (two points) It would ensure guaranteed service for the transfer of the file and minimize queueing delay.

(d) (3 points) Selective repeat algorithms are ideal for wireless links

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**Solution:** True (one point) (two points) as only one or two packets would get errors due to bit corruptions

## 3. Fill in the blanks

- (a) (2 points) A \_\_\_\_\_ is a collection of many separate networks

**Solution:** internet

- (b) (2 points) The \_\_\_\_\_ layer is at the narrow waist of the Internet protocol suite.

**Solution:** network

- (c) (2 points) The on-demand approach to sharing a network is also known as \_\_\_\_\_

**Solution:** best-effort

- (d) (2 points) The bandwidth-delay product is the number of \_\_\_\_\_

**Solution:** bits in-flight at any time

## 4. Short Answers:

- (a) (8 points) Sketch the five layers seen in the Internet architecture and explain their function in one sentence.

**Solution:** Two points for each layer. One point for the name and one point for the correct function  
encoding Bits on wire (Physical)  
Deliver packets across local network (Datalink)  
Deliver packets across country (Network)  
Reliable/unreliable transmission of packets end to end (Transport)  
Do something with the data (Application)

- (b) (2 points) Name the basic components of a multi-hop path between two end hosts

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**Solution:** links and routers/switches

- (c) A star topology is an arrangement of the end hosts in such a way that they are all connected to a central hub.  
i. (2 points) Give one example of a networked application where a star topology would help in a local area network.

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**Solution:** A file server located centrally, or any server located centrally, where the clients do not communicate with each other.

- ii. (2 points) Give one disadvantage of such a topology.

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**Solution:** Single point of failure at the central hub.

- (d) (3 points) Enumerate the end to end delay for a packet across a network shown below. Start at A  
(A) —link1— (Router1) —link2— (B)

**Solution:**

1. transmission at A-link1
2. propagation at link1
3. queueing at R1
4. processing at R1
5. transmission at R1-Link2
6. Propagation at Link2

- (e) (3 points) Goooogle recently launched a new “secure network” service, where every pair of neighboring routers on the Goooogle network would share a secret key and use this key to encrypt/decrypt the packets on each link.

Would you use this service to securely transmit your data? Why?

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**Solution:** no (1 point) , encryption/security is fundamentally an end-to-end requirement; the end-to-end argument suggests that there is no benefit from having intermediary routers do encryption. if users want private communication they would do end-to-end encryption anyway, (2 points)

5. Consider a 50Kbps satellite channel with a round trip propagation delay of 500 milliseconds. Assume A is the sender and B is the receiver. For the first four parts, assume the stop and wait protocol is implemented at the sender and receiver. Explicitly state any other assumptions you make in the solution below.

(a) (2 points) At what time will A finish transmitting a 1000-bit packet

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**Solution:**  $1000 / (50 * 1000) = 20 \text{ msec}$

(b) (2 points) At what time will B receive the full packet

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**Solution:** 270 msec (250 one way delay + 20msec)

(c) (2 points) At what time will A start to send the next packet

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**Solution:** 520 msec (250 one way delay for ack + 270 for first packet + 0ms transmission+processing delay )

(d) (2 points) What percentage of time is A blocked from sending

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**Solution:** 500/520 96 percent

(e) (4 points) Now assume A can send a window of packets as once. What is the ideal size of the window?

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**Solution:**  
The bandwidth delay prod for the link is  $50\text{Kbps} * 500\text{ms} = 25 \text{ kbits}$  (25 packets)  
or  
(25 packets +1 ) 26 packets as the ack is not generated until the first frame is completely received.