University of Illinois at Urbana-Champaign
ECE101 Exam I

Wednesday 23 February 2022

Name:

SOLUTIONS IN RED

SOLVE YOURSELF FIRST!

Net ID:

- Be sure that your exam booklet has SIX pages.
- This is a closed book exam. You may NOT use a calculator.
- You are allowed one 8.5×11" sheet for any notes (both sides).
- Absolutely no interaction between students is allowed.
- Show all work, and clearly indicate any assumptions that you make.
- Don't panic, and good luck!

Problem 1	20 points	_____
Problem 2	15 points	_____
Problem 3	25 points	_____
Problem 4	20 points	_____
Problem 5	20 points	_____
Total	100 points	_____

Problem 1 (20 points): Information and Computation

A. **(15 points)** Recall that any information, such as a choice among a group of things, can be represented using a sequence of bits (a binary number). How many bits are **needed** to represent something from each of the following? *For your convenience, a table of powers of 2 is given to the right*.

2^0	1
2^1	2
2^2	4
2^3	8
2^4	16
2^5	32
2^6	64
2^7	128
2^8	256
2^9	512

1) One of the following ice cream flavors: chocolate, strawberry, vanilla.

   # of bits required = _____2_____

2) A whole number from 1900 to 2015.

   # of bits required = _____7_____

3) A person involved with ECE 101 (we have 4 students, 1 TA, and 2 professors).

   # of bits required = _____3_____

B. **(5 points)** Which of the following sentences best restates the Church-Turing Hypothesis discussed in the lectures?

Best restatement of Church-Turing Hypothesis is number _____3_____

1) Computers are really powerful and can solve any problem, if we can figure out how to program them.

2) Humans will one day be replaced by computers.

3) Any problem that can be solved by a computer can also be solved by a human, and vice-versa.

4) Most problems that humans can solve can also be solved by computers, but a few require robots.

5) Understanding the full applicability of computers will require extraterrestrial technology.

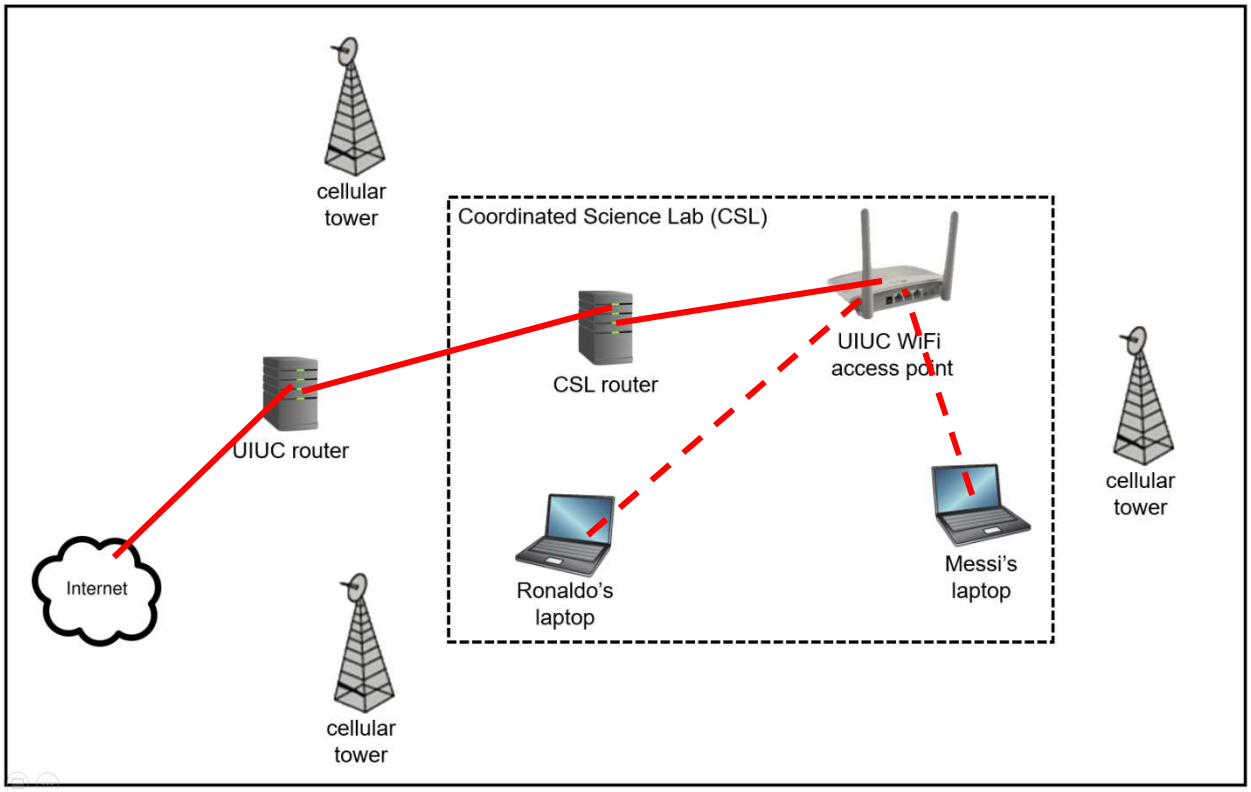
Problem 2 (15 points): Understanding How Data Moves to the Internet

Ronaldo and Messi have decided to play a game together in the lobby of the Coordinated Science Lab while their friends take the ECE101 exam.

In the diagram below, add connections as follows to enable both Ronaldo and Messi to reach the Internet:

- Draw DASHED lines to represent wireless connections such as WiFi and cell.
- Draw SOLID lines to represent wired connections.

Do not connect elements of the diagram that play no role in connecting the friends' laptops to the Internet. In other words, not everything should be connected—just the parts that are needed for the two laptops.



Problem 3 (25 points): Routing Packets through the Internet

Answer the following questions based on the graph of Internet routers shown at the bottom of the page.

A. **(9 points)** What is the least-cost route from node B to node F, and what is the cost of that route?

B → **C → F**

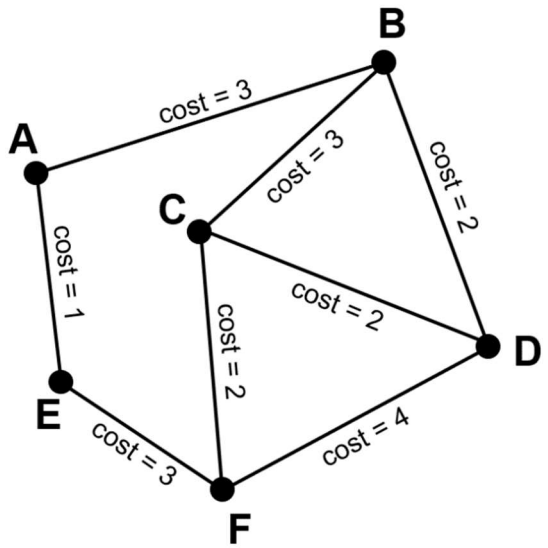
Cost = **5**

B. **(8 points)** The least-cost route from node E to node C passes through node F. In one or two sentences, explain **how the router at node F chooses the link on which to forward packets** sent along this route (from node E to node F, and destined for node C) *after the routing algorithm has completed its work.*

Router F looks up the packet's destination (C) in its forwarding table and finds that it should send the packet on the link to C.

C. **(8 points)** The link connecting nodes D and F serves no obvious purpose, since the path from F to C to D has the same cost. In one or two sentences, explain a benefit of keeping the link from D to F in the network.

If another link fails, the D to F link may be on the new best path for some pairs of nodes.



Problem 4 (20 points): Internet Services, Technologies, and Society

A. **(6 points)** Which of the following are examples of modern Internet services. **CIRCLE THE NUMBER** for each correct answer (there may be more than one).

1) Provide a list of all programs executing on the computer, including the input provided when the program was started.

2) Provide access to a set of documents by accepting requests sent using HTTP.

3) Search for URLs of interest based on keywords provided by a client.

4) Provide access to classified documents based on the name of the country provided by a client.

5) Dispense food and water to a client's pet, and take it for walks.

B. **(6 points)** After hearing that Pat has uploaded a new high-definition video to YouTube, Jan is eager to watch the video. In one or two sentences, explain a scenario in which YouTube should prepare for Jan's visit in advance by transcoding the video to another format. Be specific about the expected benefit of transcoding.

In case Jan's Internet connection has low capacity, YouTube should transcode to a format that requires fewer bits per second so that Jan can receive the video without stalls.

C. **(8 points)** In two or three sentences, explain how an attacker might use a social network to abuse a victim's existing trust relationships and/or sidestep a victim's natural deceit detection mechanisms.

(many examples are possible)

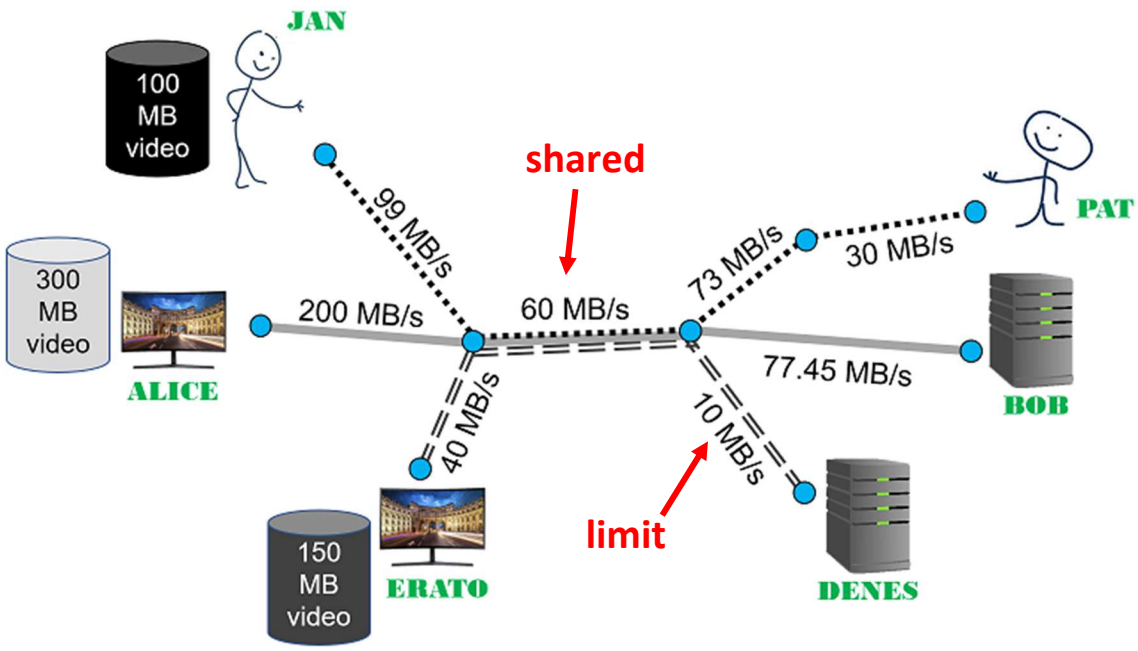
By creating several accounts and pretending that they are independent people, an attacker can convince a common "friend" (victim) that the victim is receiving independent opinions from several contacts, providing a much stronger influence to act as the attacker desires.

Problem 5 (20 points): Bandwidth Sharing along Routes

Consider the picture shown below, in which three pairs of users are trying to send videos simultaneously through a part of the Internet.

- Jan wants to send a 100 MB video to Pat (along the dotted black line),
- Alice wants to send a 300 MB video to Bob (along the solid, light grey line), and
- Erato wants to send a 150 MB video to Denes (along the double, dashed, dark grey line).

Their routes share links as shown.



Assume for all questions that TCP is able to reach the rates shown on the links, and that link sharing is fair unless one of the connections is limited by another link along its route.

A. **(5 points)** At what rate can Jan send to Pat? _____25_____ MB/s

B. **(5 points)** At what rate can Alice send to Bob? _____25_____ MB/s

C. **(5 points)** At what rate can Erato send to Denes? _____10_____ MB/s

D. **(5 points)** How long does it take Jan to send the full 100 MB video to Pat? _100/25 = 4_ seconds