

Distributed Systems

CS425/ECE428

March 8 2022

Instructor: Radhika Mittal

Logistics

- HW3 was due yesterday.
 - If you are using grace period for late submissions, today is the last day to submit the homework.
- HW4 will be released later this week (after your midterm).

Today's agenda

- Exam Review

Midterm on Thursday, March 10, 11am-noon

- Detailed instructions shared on CampusWire (post #292).
 - Go over them again.
- Syllabus:
 - everything up to and including Paxos.
 - Until ~first half of March 1st lecture.

PrairieTest

- Check your reservation time slot.
 - All conflicts and accommodations have been accounted for.
- Zoom link will be made available on your PrairieTest homepage 5-10mins before the start of your exam.
- PrairieLearn link will also be made available on your PrairieTest homepage at start time.
 - Unless you have special accommodations, you have 1hr to complete the exam (irrespective of your session duration).
- Detailed instructions linked at CampusWire post #292.

PrairieLearn

- Exam format:
 - Multiple choice questions and True/False
 - For questions with multiple choices correct, there is negative marking for selecting incorrect choices to discourage guesswork (the minimum score per question is capped at zero).
 - Numerical questions
 - No step marking!

PrairieLearn: interface example

Quizzes1: Practice Quiz

This is Quizzes 1: Practice Quiz for CS 425 / ECE 428

I certify that I am Radhika Mittal and I am allowed to take this assessment.

I pledge on my honor that I will not give or receive any unauthorized assistance on this assessment and that all work will be my own.

I certify and pledge the above.

Start assessment

PrairieLearn: interface example

Quizzes1: Practice Quiz

This assessment will only be graded after it is finished. You should save answers for all questions and your exam will be graded later. You can use the **Finish assessment** button below to finish and calculate your final grade.

Total points: 10 Assessment is **open** and you can answer questions.
Available credit: 100% (Staff override) ⓘ

| Question | Submission status | Points |
|----------------------------|-------------------|--------|
| Practice Question | | |
| Question 1 | unanswered | 10 |

- Submit your answer to each question with the **Save** button on the question page.
- After you have answered all the questions completely, click here: **Finish assessment**


This demo has only one question. Your midterm will display more than one questions.

PrairieLearn: interface example


Question 1: Testing Question

What is your favorite course?

- (a) CS 425
- (b) ECE 391
- (c) ECE 428
- (d) CS 438
- (e) CS 423

Select all possible options that apply. 

What is the minimum number of computers in a distributed system?



Is the answer to this question true?

- (a) true
- (b) false

[Save](#)

10 points available for this attempt

Quizzes 1

[Assessment overview](#)

Question


Submission status: **unanswered**

Points: 10

[Report an error in this question](#)

[Previous question](#)

[Next question](#)

 Attached files

No attached files

[Attach a file](#)


[Attach text](#)

PrairieLearn: interface example

Question 1: Testing Question

What is your favorite course?

- (a) CS 425
- (b) ECE 391
- (c) ECE 428
- (d) CS 438
- (e) CS 423

Select all possible options that apply. 

What is the minimum number of correct options?

Is the answer to this question true?

- (a) true
- (b) false

[Save](#) 10 points available for this attempt

Checkbox

You must select at least 1 option. You will receive a score of $100\% * (t - f) / n$, where t is the number of true options that you select, f is the number of false options that you select, and n is the total number of true options. At minimum, you will receive a score of 0%.

Quizzes 1

[Assessment overview](#)

Question


Submission status: unanswered

Points: 10

[Report an error in this question](#)

[Previous question](#)

[Next question](#)

 **Attached files**

No attached files

[Attach a file](#)

[Attach text](#)

PrairieLearn: interface example

The screenshot displays the PrairieLearn interface for a question. The question is titled "Question 1: Testing Question" and asks "What is your favorite course?" with multiple-choice options (a) CS 425, (b) ECE 391, (c) ECE 428, (d) CS 438, and (e) CS 423. Below this, it asks "What is the minimum number of computers in a distributed system?" with a text input field containing "0". A "Save" button is visible, along with the text "10 points available for this attempt".

On the right side, there is a sidebar with sections: "Quizzes 1" (Assessment overview), "Question" (Submission status: invalid, Points: 10, Report an error in this question), "Attached files" (No attached files, Attach a file, Attach text), and "Staff information" (Staff user: Radhika Mittal, radhikam@illinois.edu).

At the bottom, the "Submitted answer" section shows "invalid, not gradable" and "Submitted at 2022-03-08 09:37:31 (CST)". A "Format Error" message states "No answer was submitted." and "Invalid" with a "Why" button.

You must attempt all subparts of a given question for the question to be gradable.

PrairieLearn: interface example

Quizzes1: Practice Quiz

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| Question | Submission status | Points |
|----------------------------|-------------------|--------|
| Practice Question | | |
| Question 1 | invalid | 10 |

- Submit your answer to each question with the **Save** button on the question page.
- After you have answered all the questions completely, click here: **Finish assessment**


Valid responses saved for other questions will not be affected.

PrairieLearn: interface example


Question 1: Testing Question

What is your favorite course?

(a) CS 425
 (b) ECE 391
 (c) ECE 428
 (d) CS 438
 (e) CS 423

Select all possible options that apply. 

What is the minimum number of computers in a distributed system?



Is the answer to this question true?

(a) true
 (b) false

[Save](#) 10 points available for this attempt

Quizzes 1

[Assessment overview](#)

Question


Submission status: **invalid**

Points: 10

[Report an error in this question](#)

[Previous question](#)

[Next question](#)

 Attached files

No attached files

[Attach a file](#)

[Attach text](#)

PrairieLearn: interface example

Question 1: Testing Question

What is your favorite course?

- (a) CS 425
- (b) ECE 391
- (c) ECE 428
- (d) CS 438
- (e) CS 423

Select all possible options that apply.

What is the minimum number of computers in a distributed system?

Is the answer to this question true?

- (a) true
- (b) false

Save 10 points available for this attempt

Submitted answer 2 **saved, not graded** hide ^

Submitted at 2022-03-08 09:38:53 (CST)

(a) CS 425
(c) ECE 428
0 (a) true

Submitted answer 1 **invalid, not gradable** show v

Submitted at 2022-03-08 09:37:31 (CST)

Quizzes 1

Assessment overview

Question

Submission status: **saved**

Points: 10

[Report an error in this question](#)

Previous question

Next question

Attached files

No attached files

[Attach a file](#)

[Attach text](#)

Staff information

Staff user:
Radhika Mittal
radhikam@illinois.edu

Question:

PrairieLearn: interface example

Quizzes1: Practice Quiz

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Total points: 10

Assessment is **open** and you can answer questions.

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| Question | Submission status | Points |
|----------------------------|-------------------|--------|
| Practice Question | | |
| Question 1 | saved | 10 |

- Submit your answer to each question with the **Save** button on the question page.

- After you have answered all the questions completely, click here: **Finish assessment**

Policies

- It is a closed-book exam (no websites, no textbooks).
 - You are allowed one physical double-sided cheat sheet (could be typed or hand-written).
- You cannot print your exam.
- You cannot use your iPad as scratch-pad.
- *You must finish your PrairieLearn assessment before you end your Zoom proctoring session.*
- Checkout post#292 for other instructions.

Disclaimer for our agenda today

- Quick reminder of the relevant topics we covered in class, that are included in your midterm.
- Not meant to be an exhaustive review!
- Go over the slides for each class.
 - Refer to lecture videos and textbook to fill in gaps in understanding.

Topics for your midterm

- System model and Failures
- Failure Detection
- Clock Synchronization
- Event ordering and Logical Timestamps
- Global Snapshot
- Multicast
- Mutual Exclusion
- Leader Election
- Synchronous Consensus and Paxos

Topics for your midterm

- System model and Failures
 - What is a distributed system?
 - Relationship between processes
 - Synchronous and Asynchronous Systems
 - Types of failures

Topics for your midterm

- Failure Detection
 - Ping-ack and Heartbeats: what are appropriate timeout values?
 - Correctness of failure detection algorithms (accuracy and completeness).
 - Performance of failure detection algorithms (bandwidth usage and worst-case failure detection times).
 - Extending to a system of N processes.

Topics for your midterm

- Clock Synchronization
 - Clock skew and drift rates
 - External vs Internal Synchronization
 - Clock synchronization in synchronous systems
 - Cristian Algorithm
 - Berkeley Algorithm
 - NTP Symmetric mode synchronization

Topics for your midterm

- Event ordering and Logical Timestamps
 - Happened before relationship
 - Lamport Clocks
 - Vector Clocks

Topics for your midterm

- Global Snapshots
 - Process and channel states
 - Consistent cuts
 - Chandy-Lamport algorithm
 - Runs and Linearizations
 - Safety and liveness properties, stable global predicates

Topics for your midterm

- Multicast
 - Basic multicast
 - Reliable multicast
 - Ordered multicast: FIFO, Causal, Total
 - How to implement these?

Topics for your midterm

- Mutual Exclusion
 - Central server algorithm
 - Ring-based algorithm
 - Ricart Agrawala algorithm
 - Maekawa algorithm (breaking deadlock not in your syllabus)
 - Analyzing these algorithms:
 - Safety, liveness, and ordering
 - Client delay, Synchronization delay, and Bandwidth.

Topics for your midterm

- Leader Election
 - Ring election algorithm (Chang and Roberts algorithm)
 - Bully algorithm
 - Analyzing these algorithms:
 - Safety and liveness for synchronous and asynchronous systems
 - Turnaround time and bandwidth

Topics for your midterm

- Synchronous Consensus and Paxos
 - Round-based algorithm for synchronous consensus
 - Impossibility of consensus in asynchronous systems (proof not in your syllabus).
 - Paxos algorithm
 - Three roles: proposer, acceptor, learner.
 - Phase 1: *prepare* request and response.
 - When will an acceptor respond?
 - Phase 2: *accept* request (if applicable)
 - When will an accept request be sent?
 - What will be the proposed value?
 - When is a value implicitly decided? How is the value shared with the learners?
What is required to guarantee safety?

Topics for your midterm

- System model and Failures
- Failure Detection
- Clock Synchronization
- Event ordering and Logical Timestamps
- Global Snapshot
- Multicast
- Mutual Exclusion
- Leader Election
- Synchronous Consensus and Paxos

Good luck!