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Computer Science

Spring 2025: CSCI 181RT

Real-Time Systems in the Real World

Lecture 2

Thursday, January 23, 2025
Edmunds Hall 105
2:45 PM - 4:00 PM

Professor Jennifer DesCombes

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Agenda

- Go Backs
- Student Questions
- Who's On First
- Discussion on Readings
- Languages - You Want What?
- Simplest Software for a Real-Time System
- Assignment
- Look Ahead
- Action Items

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Go Backs

- General?
- Action Item Status
  - AI250121-1: Approve Submitted PERMs - OK to Close
  - AI250121-2: Mitchell Keenan to receive 1% Bonus for typo/spelling detection - OK to Close

Student Questions

- ???

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Who is on First?

-1 What is the name of the player on Second Base?_____

-2 What City do the players play for? _____

-3 What is the name of the player on Third Base? _____

-4 When Sebastian offers to play catcher for the team, he describes throwing the batter out at first after the batter _____ the ball.

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Who is on First? Who is on First.

-1 What is the name of the player on Second Base?____**What**_____

-2 What City do the players play for? _____**St. Louis**_____

-3 What is the name of the player on Third Base? ____**I Don't Know**_____

-4 When Sebastian offers to play catcher for the team, he describes throwing the batter out at first after the batter ___**bunts**____ the ball.

- Communications Between Two People or Groups
- Clarity
- Rephrase

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Discussion on Readings

- Lecture Reading

  Course Syllabus

  https://www.intel.com/content/www/us/en/robotics/real-time-systems.html

  https://www.windriver.com/solutions/learning/rtos

  [NOTE: Skip marketing material at the end]

- Lab Reading

  CURIOSITY PIC32MZ EF 2.0 DEVELOPMENT BOARD

  Microchip Part Number: DM320209

  https://www.microchip.com/en-us/development-tool/DM320209

  https://ww1.microchip.com/downloads/aemDocuments/documents/MCU32/ProductDocuments/UserGuides/PIC32MZ-EF-2.0-Development-Board-Users-Guide-DS70005400.pdf

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Discussion on Readings - Syllabus

Course Grading

Course grading is primarily based on participation. Joining in in-class discussions is an important part of this course. Grading is based on the following:

Participation	Weighting
Class Attendence	30%
Lab Attendence	30%
Reading Commentaries	30%
Quizes	10%
Errors Found in Course Material	+1% Bonus per error up to a maximum of 10%

The grading policy may evolve during the course, but no change in the grading policy will negatively impact any and all prior course performance

One redo, or throwaway can be used for each performance category, quiz, lecture participation, reading commentaries, and lab participation.

Letter grading scale will follow a nominal 90% to 100% = 'A', 80% to 89.999% = 'B', etc. Students will be regularly briefed on their participation performance. Students are invited to meet with me during office hours to discuss assignments and course performance.

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Discussion on Readings - Syllabus

Academic Honesty and Collaboration

I encourage you to study and work on exercises with your peers (unless otherwise specified). If you are ever unsure about what constitutes acceptable collaboration, please ask!

For more information, see the Computer Science Department and the Pomona College policies.

I take violations of academic honesty seriously. I believe it is important to report all instances, as any leniency can reinforce (and even teach) the wrong mindset ("I can get away with cheating at least once in each class.").

Academic Advisory Notice

I will do my best to update you if I think you are not performing at your best or if you are not on pace to pass the class. I will first reach out to you and then use the system built-in to my.pomona.edu that will notify your advisor so you are encouraged to work with a mentor or advisor on a plan.

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Discussion on Readings - Syllabus

Attendance

Except for illness (discussed previously), I expect you to attend every class, but I will not directly penalize you for missing class. Know that there is a strong correlation between attendance and grades, and you will almost certainly be indirectly penalized.

You are responsible for any discussions, announcements, or handouts that you miss, so please reach out to me. If you need to leave class early for any reason, please let me know before class begins so that I am not concerned when you leave.

Late Submissions

Late assignments will be accepted, but at a lower value than if received on time. However, if you plan ahead you can ask for an extension prior to the assignment deadline (at least four days).

Unless requested ahead of time, some assessments (e.g., quizzes) cannot be completed after the class period in which they are scheduled.

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Discussion on Readings - Syllabus

Teaching Philosophy

I above all aim to be a thoughtful teacher. Here are a few thoughts on my teaching mindset:

- I can teach you, and you can teach each other, how to be a better learner.
- Lessons are retained longer when learning is harder.
- You will always be supported; you are never alone.
- You are only competing with yourself; you've already "made-it".
- Diversity, equity, and inclusion are important.
- Honest, kind critique is essential to learning (feedback).

Discussion on Readings

Soft real-time is when a system continues to function even if it's unable to execute within an allotted time. If the system has missed its deadline, it will not result in critical consequences. The system can continue to function, though with undesirable lower quality of output.

Hard real-time is when a system will cease to function if a deadline is missed, which can result in catastrophic consequences.

Discussion on Readings

5 CHARACTERISTICS OF AN RTOS

Determinism: Repeating an input will result in the same output.

High performance: RTOS systems are fast and responsive, often executing actions within a small fraction of the time needed by a general OS.

Safety and security: RTOSes are frequently used in critical systems when failures can have catastrophic consequences, such as robotics or flight controllers. To protect those around them, they must have higher security standards and more reliable safety features.

Priority-based scheduling: Priority scheduling means that actions assigned a high priority are executed first, and those with lower priority come after. This means that an RTOS will always execute the most important task.

Small footprint: Versus their hefty general OS counterparts, RTOSs weigh in at just a fraction of the size. For example, Windows 10, with post-install updates, takes up approximately 20 GB. VxWorks®, on the other hand, is approximately 20,000 times smaller, measured in the low single-digit megabytes.

Languages - You Want What?

- Currently Popular Languages
- Historic Languages
  - Fortran, ALGOL and LISP, COBOL, BASIC (Dartmouth), PASCAL
  - C, C++, C#
- Intellectual Property (IP)
- Development Risk
  - Legacy Projects
  - Legacy Knowledge

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COLBAL

```
PROCEDURE DIVISION.
*> compute num1 times num2 and store result in numc
COMPUTE NUMC = (NUM1 * NUM2).
*> divide numa by numb and store result in res-div
DIVIDE NUMA BY NUMB GIVING RES-DIV.
*> multiply numa by numb storing result in res-mult
MULTIPLY NUMA BY NUMB GIVING RES-MULT.
*> subtract numa from numb store result in res-sub
SUBTRACT NUMA FROM NUMB GIVING RES-SUB.
*> add numa to numb and store result in res-add
ADD NUMA TO NUMB GIVING RES-ADD.
*> the pointer from numa to
MOVE NUMA TO RES-MOV.
*> reinitilize num1
INITIALIZE NUM1.
*> reinitilize num2 but replace numeric data with 12345
INITIALIZE NUM2 REPLACING NUMERIC DATA BY 12345.
DISPLAY "NUMC:"NUMC
```

C Language

C is a general-purpose programming language which features economy of expression, modern control flow and data structures, and a rich set of operations. C is not a “very high level” language, or a “big” one, and is not specialized to any particular area of application. But its absence of restrictions and its generality make it more convenient and effective for many tasks than supposedly more powerful languages.

In our experience, C has proven to be a pleasant, expressive, and versatile language for a wide variety of programs. It is easy to learn, and it wears well as one’s experience it grows.

From “Preface to the First Edition”, *The C Programming Language*, Kernighan and Ritchie.

Why C for This Course and Labs?

- Useful to Know - Common in Industry
- Legacy Knowledge
- Existing and Consistent Code Appearance
  - Programming Style
  - Comments
- Legacy Projects
- Well Supported

Historical Tidbit

- Hello World

Simplest Software for a Real-Time System

- Simple Systems Will Support Simple Implementations
  - Low Rate Data Inputs
    - Humans are Slow in Time Domain
  - Low Accuracy Output
    - Simple On/Off
    - Duration and Response Time Not Critical
- Procedural Based Polling System
  - Determine Input Status
  - Configure Outputs to Match System Condition
- First Lab will Demonstrate This Design Approach

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Assignment - Readings

- Lecture Reading

  Coding From 1849 to 2022: a Guide to The Timeline of Programming Languages
  https://www.computer.org/publications/tech-news/insider-membership-news/timeline-of-programming-languages

  The Development of the C Language
  https://www.bell-labs.com/usr/dmr/www/chist.html

  K&R - Intro through Page 66

- Lab Reading - Ongoing, No New Assignments

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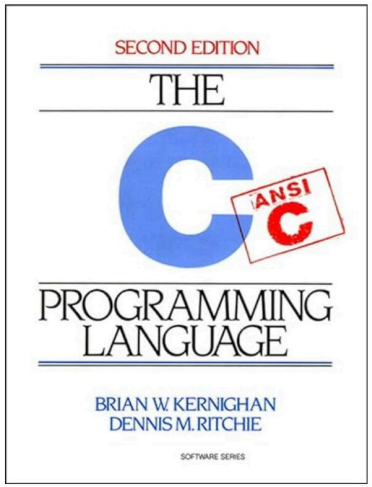
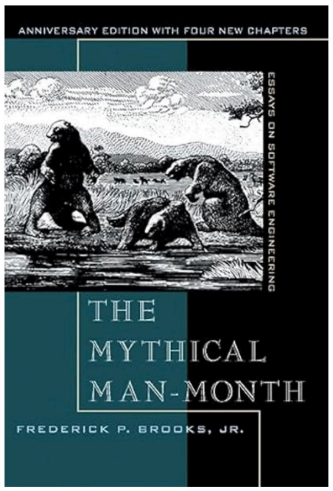
Readings Texts

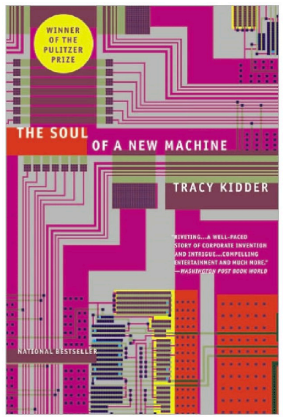


The C Programming Language, 2nd Edition 2nd Edition
by Brian W. Kernighan (Author), Dennis M. Ritchie (Author)
Approximately $70 new, $50 Kindle, $40 and lower used.

The Mythical Man-Month, The: Essays on Software Engineering, Anniversary Edition
by Frederick Brooks Jr. (Author)
$35 New, $31 Kindle, $30 and lower used.



The Soul of A New Machine
by Tracy Kidde
$20 New



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Look Ahead

- Discussion on Readings
- More on Simple Real-time Systems
- Lab Planning - First Design

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Action Items and Discussion

AI#:	Owner	Slide #	Document	Action