Educational information systems and networks

Matthew X. Curinga

Tom Jennings

Christian Correa

David Frackman

Table of Contents

**0858-606, Summer 2021**

**Description:** From a foundation of computer networks and systems, this course expands to cover instructional technology infrastructure: file systems, users, wired and wireless networks, email, web servers, computer labs, and common educational software services. This course focuses on Free Software; where the source code is free to use, study, or modify. To explore these topics in this hands on class all students will be configuring their own Raspberry Pi computers and using them to complete a software/hardware project.

**Keywords:** linux, bash, systems, networks, lamp, free software, trouble shooting, technical project management, rasberry pi, physical computing, debian, ubuntu

# Goals & Objectives

This course introduces students to the key concepts in current networked computing in order to develop a conceptual framework for configuring and troubleshooting computing systems. Upon completing this course they will be able to:

* set up a secure, network computing environment
* effectively use the basic tools of GNU/Linux computing environments
* implement techniques for administering group and user permissions
* install and troubleshoot hardware and software infrastructure for networked and internet computing
* configure a client/user computer for specific purposes
* configure various server-side applications to support teaching and learning
* identify the ethical and legal concerns surrounding educational information systems

# Class Information

**Instructor:**

Matt Curinga [mcuringa@adelphi.edu](mailto:mcuringa@adelphi.edu)

**Class dates:**

Wednesday, May 26 - Tuesday, June 29

**Live sessions:** - Wednesdays: 4:30pm - 6:20pm - zoom link on moodle

# Course Communications

This online course will have a mix of synchronous and asynchronous assignments. The synchronous sessions, “live lab,” will be held each Wednesday, via Zoom, 4:30pm to 6:20pm.

Participants in this course must actively participate in our suite of online communications tools, including Slack (<https://auedtech.slack.com>), Adelphi email, and the course website.

You *must* check your Adelphi email and the #raspberrypi channel on Slack **at least once a day.** It is highly recommended that you install the Slack mobile client and an email client on your mobile phone so that you receive “push notifications” of course announcements.

The best place to post general course questions and any content-related questions is the #raspberrypi Slack channel. The instructor, as well as other students and alums, monitor this channel and often provide immediate support. You are encouraged to contact the instructors at any time via email or direct message on Slack.

**Online tools:**

* **Moodle:** will be used to post the syllabus and links to weekly readings, videos, and discussions.
* **Slack:** will be our main channel for online communications. Please [Join our Slack team with your Adelphi email](https://auedtech.slack.com/signup). If you run into trouble or have a question, post it here to our channel, #raspberrypi, or send a message to @mxc. During the weeks of the class, we recommend running the Slack app for you phone.
* **Trello:** is project management software that you will use to track/plan your two projects, and to share your progress with the course instructors. Create a [Trello Account](https://trello.com/signup) before the first week of class, and (optionally) [install the mobile app](https://trello.com/platforms).
* **mail.adelphi.edu email:** we will use your official adelphi student email for class email communications. Please check this email regularly.

**Getting remote help:**

Because of the hands on nature of working with computers and Raspberry Pi, you will have to use a variety of tools to get help. Your first stop for help should be #raspberrypi on Slack. You are most likely to get quick help if you post here because anyone in the channel (instructors, other students, other faculty, ed tech alums) can lend a hand.

For more complicated problems, you will need to be able to:

* [post formatted code in slack](https://get.slack.help/hc/en-us/articles/202288908-Format-your-messages)
* [take a screenshot from your RPI](https://wiki.debian.org/ScreenShots#Using_Gnome)
* [create a google hangout/meeting with screensharing](https://support.google.com/meet/answer/7290345?co=GENIE.Platform%3DDesktop&hl=en)
* enable remote access to instructors to your RPI via ssh – at the end of the first week, you should have ssh enabled on your Pi. To enable remote access you will probably have to enable Network Address Translation (NAT) on your wifi router. If you are on public wifi (e.g. school, library, coffee shop), you probably won’t be able to enable remote access. NAT is not hard to configure, but it’s specific to the wifi router that you’re using. You will have to search “configure network address translation” along with your router make and model.
* [connect to your RPI with VNC](https://www.raspberrypi.org/documentation/remote-access/vnc/) (once you’re comfortable with NAT, you can also configure NAT for VNC if needed)

# Required Books

*None*

# Required Materials

## Desktop/Laptop

You must have access to a desktop computer running Linux, Windows, or MacOS to participate in this course. You will use this computer to participate in the course online and to configure and connect or your RPI. You can use a phone or tablet for some online elements of the course, however you will not be able to complete course assignments without access to a computer where you are able to install software.

In addition to the computer, you must have a webcam, headphones, and microphone to participate in live video chat and to record your screencasts.

## Raspberry Pi

Every student *must* purchase a Raspberry Pi (RPI) computer and accessories for use in this course. You will keep your own hardware. If you already own a Raspberry Pi, of course you can use it for this course. You can pick up these items in person at a local [MicroCenter](https://www.microcenter.com/) ([view items in wishlist](https://account.microcenter.com/PublicWishList.aspx?WishListID=4Yt4PUuytCb2roLGPinnTH5Itg3JsOKt&Email=SXkm0QpXuD%2b%2fxxyZcAguSK2mIABUJbA7)) or purchase them online.

Required hardware:

* Raspberry Pi model 4 (2GB model recommended): [[SparkFun](https://www.sparkfun.com/products/15446)] [[Amazon](https://www.amazon.com/Raspberry-Model-2019-Quad-Bluetooth/dp/B07TD42S27)] [[AdaFruit](https://www.adafruit.com/product/4295)]
* 16GB (or larger) Micro SD Card (at least 2 recommended)
* micro hdmi cable [[SparkFun](https://www.sparkfun.com/products/15796)] [[Amazon](https://www.amazon.com/dp/B07VRCK5W1/)] [[AdaFruit](https://www.adafruit.com/product/4302)]
* 5.1V 3A USB-C wall charger [[SparkFun](https://www.sparkfun.com/products/15448)] [[Amazon](https://www.amazon.com/Raspberry-Model-Official-SC0218-Accessory/dp/B07W8XHMJZ/)] [[AdaFruit](https://www.adafruit.com/product/4298)]
* micro SD card reader: these are built into many modern laptop and some desktops, but any card reader/writer that works with your computer (USB 2, USB 3, USB-C) will work. You should be able to find one for less than $10 on [Amazon](https://www.amazon.com/dp/B08BBX4YM1/) or in a local store (Staples, Best Buy, Microcenter).

You will need (but can re-use existing):

* USB Keyboard and Mouse [[wireless](https://www.amazon.com/dp/B014EUQOGK/)] [[wired](https://www.microcenter.com/product/485045/inland-ic-210-premium-mouse-keyboard-combo)]
* Computer Monitor or TV with HDMI input

*You must have all of the required hardware* ***before*** *the first week of class.*

If you purchased everything except the monitor it would cost $80-$90.

In addition to these core materials, you will also need to purchase/acquire materials to complete your final project (see below). Costs may range from $20-$80.

# Books & Resources

* [Raspberry Pi Foundation](https://www.raspberrypi.org/)
* Crowley, C. 2017. [*Raspberry Pi: The Unofficial Tutorial*](http://cdn.makeuseof.com/wp-content/uploads/2017/07/Raspberry-Pi-The-Unofficial-Tutorial.pdf)
* [Make: Magazine](https://makezine.com/)
* [Explaining Computers Series](https://www.youtube.com/user/explainingcomputers/videos) (Youtube)

# Schedule

|  |  |  |
| --- | --- | --- |
| Week | Date | Topic |
| 1 | Wed, May 26 | Computers & Operating Systems |
| 2 | Wed, Jun 2 | The Command Line |
| 3 | Wed, Jun 9 | Users, Groups, Files, & Permissions |
| 4 | Wed, Jun 16 | Networks |
| 5 | Wed, Jun 23 | Ethics |
| 6 | Tues, Jun 2 | 9 DIY Project Due |

# Grades & Assignments

|  |  |  |
| --- | --- | --- |
| Assignment | Pct | Due |
| Participation | 20% | ongoing |
| RPI Client or Server Setup | 40% | 6/15 |
| DIY Project | 40% | 6/29 |

## Participation

Because this is a short summer course (3 credits in 6 weeks), you should budget 10-15 hours each week for course work. Wednesday live lab sessions are required, but you will also spend significant time working through course materials at your own pace.

Your participation grade will consider preparation for live labs, timely management of your Trello projects, and participation in Slack and Moodle discussions. Smaller (ungraded) weekly assignments will also be considered for your participation grade.

## RPI Client or Server Setup

For our first project you will configure your Raspberry Pi for a specific educational scenario: a general computer for 4th grade classroom computer station, a setup to teach computer programming for kids, a development server for the Canvas LMS, a workstation configured with assistive technology to support users with different physical needs, a web server to host static HTML/Javascript projects, a managed computer lab setup, etc. Whatever scenario you choose, your installation should be precisely tailored to meet the needs of your target users.

You will present your project as a narrated screencast. In addition to demonstrating the software, you will upload a report which details:

* a description of the target audience and how you envision they would use the RPI
* the process you used to find, test, and configure the RPI
* key features of the software installed
* advantages, disadvantages, and other implications of your design

You will be evaluated on:

* demonstration of your understanding of RPI hardware and software
* suitability of your solution for your stated audience/problem
* risk/complexity of the task undertaken
* reflection on the process

*This is an individual project.*

## DIY Project

One of the key technical tasks of an educational technologist or instructional designer is to research and evaluate possible solutions to a problem and then implement a plan to test a possible solution. Real world problems often require the combination of several systems in a new way, suffer from incomplete or inaccurate documentation, and are hindered by time or resources/financial constraints.

With this in mind, you will choose an RPI project that you find interesting and engaging to pursue for your final project. You will be responsible for gathering/purchasing the materials to complete the project.

You will be evaluated on:

* skill with RPI hardware
* skill with RPI software
* creativity of the project chosen
* risk/scope of the project
* reflection on the process

This is a *paired project.* You and a partner of your choice will work on the same project. You will share a Trello and set goals together, however you will both complete the project independently and will receive an individual grade. Your partner will serve as a resource for planning and troubleshooting problems that arise during the course of the project.

With the instructors’ permission, you may work on this project individually.

Here are a few project ideas that will give you a sense of the size and scope of project to choose:

1. **MyCroft Open Source personal assistant** <https://mycroft.ai> MyCroft is a Free Software alternative to systems such as Alexa and Google Assistant. While it runs on a regular desktop computer, it was designed to work on a RPI. You can download a pre-configured SD Card image to get started with “PiCroft”. For this project, you will download and configure MyCroft for your Pi; create and connect to your online account, configure and test the microphone and audio output, and customize the features and functionality of your RPI assistant. Start at the [mycroft site](https://mycroft.ai) for all of the information you need to get started.
2. **RetroPi Arcade Console** <https://retropie.org.uk/> Do you think that Fortnite has nothing on the original Streetfighter? That Assassin’s Creed pales in the glow of Golden Eye? Or do you just want to play the Super Mario Bros, the greatest video game of all time? Turn your RPI into a video game emulator that can play the classics made for Artari, Nintendo NES, Sega, and more. Once you’ve got the general system up and running, you can add some custom controllers and make it an upright arcade.
3. **Raspberry Pi Light Show** <https://www.raspberrypi.org/blog/christmas-lights/> & <https://opensource.com/life/15/2/music-light-show-with-raspberry-pi> Want to turn your classroom into a disco or put your neighbors to shame this Halloween or Christmas? Even if you don’t, you should [check out this sick RPI Christmas display](https://youtu.be/90oZ52M4IC0).
4. **Mini Creature Home** <https://allenheard.wordpress.com/2013/11/06/making-a-mini-beast-habitat-raspberry-pi-style/> Create an ant or snail home, complete with a live webcam. This project should give you lots of ideas if your looking for STEAM projects for younger kids.
5. **MagicMirror** <https://magicmirror.builders/> The magic mirror or smart mirror is an RPI favorite: put a reflective coating or 2-way mirrored plexiglass over an old monitor or TV, hook it up to your Pi, and throw up you daily calendar, the bus schedule, weather, news, poetry, etc.
6. **Digital (Pi)cture Frame** <https://www.makeuseof.com/tag/showerthoughts-earthporn-make-inspiring-raspberry-pi-photo-frame/> If the *mirror* seems like it might be too much, how about a digital picture frame?

These are just a few of the many possible projects. You may conceive of your own project, or check out some of these other ideas:

* [circuit specialists](https://www.circuitspecialists.com/blog/best-raspberry-pi-projects/)
* [tom’s hardware](https://www.tomshardware.com/features/best-raspberry-pi-projects)
* [it’s foss](https://itsfoss.com/raspberry-pi-projects/)

# Class Sessions

## Week 0: Before Class Begins

**To Do:**

1. Order your Raspberry Pi and related equipment
2. [Join Slack](https://auedtech.slack.com) and install the desktop and mobile apps ([slack support](https://get.slack.help/hc/en-us))
3. Create an account on [Trello](https://trello.com) and install the mobile app ([Trello Support](https://help.trello.com/))

## Week 1: Computers & Operating Systems

This week we will learn about core computer hardware, and the key software (Operating Systems) that drive computers. We’ll also learn about the specific hardware of our RPIs and install an operating system so we can take them out for a test drive. By the end of the week you should have a bootable Raspberry Pi that is housed in a homemade case of your design. You should be able to log into your computer with a working display (monitor) and keyboard/mouse. You will also make sure that it connects to the internet.

**Week 1 Guiding Questions:**

1. How does a modern computer work?
2. What makes a computer a *computer*?
3. How is a computer an abstraction of many parts and processes?

**Watch & Read:**

1. [Computer Hardware](https://www.youtube.com/watch?v=ExxFxD4OSZ0) (Computer parts Explained) [7:48]
2. [RPI Hardware](https://www.youtube.com/watch?v=SgR_5Ai64nM) (Urban Penguin) [2:01]
3. [*Unofficial Raspberry Pi Manual*](https://www.makeuseof.com/tag/great-things-small-package-your-unofficial-raspberry-pi-manual/) [ [pdf](http://cdn.makeuseof.com/wp-content/uploads/2017/07/Raspberry-Pi-The-Unofficial-Tutorial.pdf) ] Sections 1-3
4. [What is an OS?](https://www.youtube.com/watch?v=26QPDBe-NB8) (Crash Course Computer Science) [13:35]
5. [What is Free Software?](https://www.fsf.org/about/what-is-free-software) (The Free Software Foundation)
6. Klint Finley. (April 24, 2019) [The WIRED Guide to Open Source Software](https://www.wired.com/story/wired-guide-open-source-software/). *WIRED*.

**To Do:**

*Complete all the videos/readings before the first live session on Wednesday.*

1. Complete all of the readings *before* our first class meeting.
2. Install Raspbian on your RPI. [[instructions](https://www.raspberrypi.org/documentation/installation/installing-images/README.md)]
3. Make a case for your RPI and post a picture on Slack (see *Unofficial Manual* Section 3.1)
4. Get to know your new computer by connecting it to your network, installing software, etc.
5. After your Pi is up and running, the first thing you want to enable is a remote connection via ssh. [Follow this guide to enabling ssh](https://www.raspberrypi.org/documentation/remote-access/ssh/).

**Live Lab Agenda**

1. Introductions
2. Kahoot competition: review of videos/readings
3. Breakout Rooms A. Room A: Installing Raspbian and Booting your Pi for the first time B. Room B: Configure ssh, make a case

## Week 2: The Command Line

This week we will learn how to interact with our computer using the command line (aka terminal). The command line interface (CLI) offers an alternative to the graphical user interface (GUI) we are more familiar with. Wile the terminal hearkens back to the early days of computing, its still very much alive for systems administrators, software developers, and others. In particular, complex tasks can be accomplished with a few lines of text, remote computers can be easily accessed, and all manner of tasks can be automated (and scheduled). Specifically, after gaining fluency with the command line, you will be able to log into your RPI from your regular laptop or desktop computer in order to configure and control it. To get started on the command line we’ll check out Terminus, a game developed at MIT to introduce the players to the command line.

In addition to jumping into the command line, by the end of the week you will have customized your RPI by installing software packages through apt and the GUI. You will also choose your topic for the first project and set up a Trello with a Board for your project and milestones for each week until it’s due.

**Week 2 Guiding Questions:**

1. How is a command line interface different from the more familiar graphical user interface?
2. What is gained from a CLI? What is lost?

**Watch, Play, & Read:**

1. Read [What is Free Software?](https://www.gnu.org/philosophy/free-sw.en.html)
2. Watch [Keyboards & Command Line Interfaces: Crash Course Computer Science #22](https://www.youtube.com/watch?v=4RPtJ9UyHS0)[11:23] Hackers are fast typists.
3. Play [Terminus](http://web.mit.edu/mprat/Public/web/Terminus/Web/main.html) for at least an hour. Post on Slack how far you get.
4. Read [Chapter 5 in *Unofficial Tutorial*](https://www.makeuseof.com/tag/great-things-small-package-your-unofficial-raspberry-pi-manual/#chapter-5)

**To Do:**

1. Update the software on your RPI with apt (hint sudo apt update then sudo apt dist-upgrade)
2. Install VNC and [connect to your RPI from your computer](https://www.raspberrypi.org/documentation/remote-access/vnc/)
3. Install at least 2 programs on your RPI using apt or the graphical software package manager. See [5 Ways To Install Software On Raspberry Pi](https://www.makeuseof.com/tag/three-ways-to-install-software-on-raspberry-pi/)
4. Post in the FOSS Apps Discussion which apps you installed and a brief review of them.
5. Create a Trello Board for your project and invite the course instructors as collaborators.

## Week 3: Users, Groups, Files, & Permissions

As you’re working on finishing up your first RPI project, we’ll take a deeper look at how files, permissions and security works on RPI and in linux/unix operating systems generally. To better understand how to work with files, we’ll take a look at file archives (multiple files and directories combined in a single file) and compression (reducing the size of a file). Because your programs all run as a “user” (either root or their own user), it’s important to understand files and permissions to troubleshoot problems.

**Week 3 Guiding Questions:** https://auedtech.slack.com 1. How do you secure digital resources? 2. Is the unix approach of users and groups sufficient for all security needs?

**Watch & Read:**

1. Watch [Files & File Systems: Crash Course Computer Science #20](https://www.youtube.com/watch?v=KN8YgJnShPM) [12:02]
2. Watch [Compression: Crash Course Computer Science #21](https://www.youtube.com/watch?v=OtDxDvCpPL4) [12:47]
3. Read [Understanding Basic File Permissions and ownership in Linux](https://www.thegeekdiary.com/understanding-basic-file-permissions-and-ownership-in-linux/)
4. Watch [Linux Terminal 201: How To Use tar, gzip, bzip2, and zip - HakTip 156](https://www.youtube.com/watch?v=f8-7lhs4ky0) [11:32]
5. Docs [Linux users](https://www.raspberrypi.org/documentation/linux/usage/users.md)
6. Docs [How To Extract Zip, Gz, Tar, Bz2, 7z, Xz and Rar File in Linux](https://tecadmin.net/extract-archive-file-linux/)

**To Do:**

* finish RPI Client or Server Setup project by the end of the week

## Week 4: Networks

How does the internet work? What happens after you hit enter on a search term on [Duck Duck Go](https://duckduckgo.com/spread)? How does Spotify get music to your phone to your wireless earbuds? A deeper understanding of different networking hardware, software, and protocols will help us better understand the networked software we’re installing, configuring, and troubleshooting.

**Week 4 Guiding Questions:**

1. How does the internet work as a collection of networks?
2. How does a multi-layered model allow for abstraction between different layers?

**Watch:**

1. [How the Internet Works in 5 Minutes](https://www.youtube.com/watch?v=7_LPdttKXPc) [4:48]
2. [The Internet: IP Addresses & DNS](https://www.youtube.com/watch?v=5o8CwafCxnU) [6:44]
3. [The Internet: Wires, Cables & Wifi](https://www.youtube.com/watch?v=ZhEf7e4kopM&list=PLzdnOPI1iJNfMRZm5DDxco3UdsFegvuB7&index=2) [6:41]
4. [The Internet: Packets, Routing & Reliability](https://www.youtube.com/watch?v=AYdF7b3nMto&list=PLzdnOPI1iJNfMRZm5DDxco3UdsFegvuB7&index=4) [6:25]

**To Do:**

1. For a more in-depth look at a networking, you will work with a partner to write a mini report on related topics. Please: a) choose a partner, and b) choose a topic from the list below. If you have an idea for a different topic, you may write about that with approval from the instructors. By the end of the week, please post your report directly into our *Networking Topics* forum. Your report should be roughly 500-800 words. It should give an overview of the topic, summary of how it works, and discussion of how it’s used and why it is (or isn’t) important. Read through the other posts, and ask any follow-up questions. The instructors and topic authors will do their best to answer your questions.

* Possible topics:
  1. Bluetooth
  2. Mesh network
  3. Near Field Communication (NFC)
  4. HTTPS/SSL
  5. 4g/5g/6g
  6. BitTorrent
  7. Dark Web
  8. Radio-frequency identification (RFID)
  9. Bluetooth Beacons

1. Choose a topic and a partner for your final project. Create a Trello board for it and share it with your partner and the instructors.

## Week 5: Ethics

[As Spider-Man learned](https://www.marvel.com/comics/issue/17610/spider-man_with_great_power._2008_1), with great power comes great responsibility. We trust the people who run our networks to keep our information safe, and to not violate our trust while they do it. Along the way, they may face some hard choices, usually weighing the benefits of individuals versus the group. We’ll take a look at some of the ethical concerns in “big tech”, and also investigate how these same concerns appear in the context of schools and other educational institutions.

**Week 5 Guiding Questions:**

1. How do school systems balance student privacy and autonomy, with safety and learning efficiency?
2. What are the key ethical concerns of embedding corporate interests (and technology) into public spaces like schools?

**Read:**

1. **Monitoring Student Social Media**
   1. Karen Turner. April 22, 2016. [Schools are helping police spy on kids’ social media activity](https://www.washingtonpost.com/news/the-switch/wp/2016/04/22/%20schools-are-helping-police-spy-on-kids-social-media-activity/). *The Washington Post*. [alternate link](https://adelphi.summon.serialssolutions.com/#!/%20search?bookMark=ePnHCXMw42JgAfZbUzkZbCHHSBYrJBalKmSk5oC2_yiAbh5ITlUoLqhUyM9TyM5MKVZXgAwOK4B3SiiAVvODLk3gYWApKSpN5YVQ3Awabq4hzh66sOIyHhgIoJHtxLxUYAc53hC0F8EUdJye%20MQlKAdaHN6s)
   2. Aaron Leibowitz. September 6, 2018. [Could Monitoring Students on Social Media Stop the Next School Shooting?](https://www.nytimes.com/2018/09/06/us/social-%20media-monitoring-school-shootings.html). *The New York Times*.
   3. Tom Simonite. August 20, 2018. [Schools Are Mining Students’ Social Media Posts for Signs of Trouble](https://www.wired.com/story/algorithms-monitor-student-%20social-media-posts/). *Wired*.
2. **Student Data**
   1. [Student Privacy](https://www.eff.org/issues/student-privacy). *Electronic Frontier Foundation*.
   2. Natasha Singer. May 13, 2017. [How Google Took Over the Classroom](https://www.nytimes.com/2017/05/13/technology/google-education-chromebooks-%20schools.html). *The New York Times*.
   3. Gennie Gebhart. March 28, 2017. [Privacy By Practice, Not Just By Policy: A System Administrator Advocating for Student Privacy](https://www.eff.org/deeplinks/2017/03/privacy-practice-not-just-policy-system-administrator-advocating-student-privacy). *Electronic Frontier Foundation*.

**To Do:**

1. Post a reaction in the Ethics Discussion (by end of day Wed).
2. Comment on at least 2 reaction posts (end of week). Respond to comments on your own post.
3. Update your Trello project with the work you’ve completed this week. Identify any issues and get help as needed.

## Week 6: Final Project Due

This is a working week where our full attention is focused on producing great final projects.

**To Do:**

* turn in your final project and have a great summer!