

Course Syllabus



EEL 5789 Software-Defined Networking, Spring 2024

Department of Electrical and Computer Engineering

University of Central Florida

Tuesdays and Thursdays 4:30 – 5:45 PM

Classroom: ENG 1 Room O386A

Instructor: Shafaq Chaudhry

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Office hours:

Generally Wednesdays and Fridays from 4:30 PM - 6:00 PM via Zoom [link](#). <https://ucf.zoom.us/j/98924813857?pwd=WXdMjB2TXJLZFo3TEJNdFBBV2htUT09>

Please check the [Office Hours Schedule \(https://webcourses.ucf.edu/courses/1452387/pages/office-hours-schedule\)](https://webcourses.ucf.edu/courses/1452387/pages/office-hours-schedule) for any cancellations or updates to the scheduled office hours.

Or by appointment (email me to schedule time).

Registration Information:

- **Subject:** EEL
- **Course Number:** 5789
- **Course ID:** 047180
- **Class Number:** 19920, 19921, 19919
- **Section Number:** 0R01, 0V91, 0002

Objective

The Internet's routing and switching speeds have been on super-linear increase to cope with the exponentially growing traffic demand. As the load on the Internet's backbone increased, it has employed more sophisticated solutions which, in turn, caused associated labor and management costs to increase. To respond to the increasing complexity in the core, the networking community has moved to techniques with cheaper management costs via more virtualization and centralization of the protocol functions. This trend came with separation of control and data plane networking functions, a paradigm named as 'software-defined networking' (SDN). This course covers fundamentals of SDN, its basic design

tradeoffs, potential applications, and relations with network function virtualization (NFV). It explores emerging applications of SDN in network management, traffic engineering, and software-defined exchanges (SDXes). The course offers hands-on exercises of SDN protocols such as OpenFlow and ONOS.

Description

Fundamentals of software-defined networking (SDN). Control, data, and management plane separation. Northbound and southbound APIs. Network function virtualization (NFV), network orchestration, service chaining. SDN and NFV protocols and controllers such as OpenFlow, OpenDaylight, and Open Network Operating System (ONOS).

Prerequisites

Required:

- EEL 4781 Computer Communication Networks or equivalent, or consent of instructor.
- Strong knowledge of Python, Java, C/C++ or a similar programming language.

Desired:

- Working knowledge of UNIX environments and scripting languages.

Textbooks

There is no required textbook for this course. Since this is an advanced level class, the textbook is only the starting point for the majority of topics that we will cover. The lectures will cover ideas from a broad range of sources including other books, papers, and RFCs. In addition, the following books are recommended but not required:

- [GBC] P. Goransson, C. Black, and T. Culver. (2017) [Software Defined Networks: A Comprehensive Approach](https://www.elsevier.com/books/software-defined-networks/goransson/978-0-12-804555-8) ↗ (https://www.elsevier.com/books/software-defined-networks/goransson/978-0-12-804555-8), (2nd Edition). Morgan Kaufmann. (ISBN: 978-0-12-804555-8)
- [GN] K. Gray and T. D. Nadeau. (2016) [Network Function Virtualization](https://www.elsevier.com/books/network-function-virtualization/gray/978-0-12-802119-4) ↗ (https://www.elsevier.com/books/network-function-virtualization/gray/978-0-12-802119-4). Morgan Kaufmann. (ISBN: 978-0-12-802119-4)
- [NSN] A. Nayyar, B. Singla, and P. Nagrath (eds.). (2022) [Software Defined Networks: Architecture and Applications](https://www.wiley.com/en-us/Software+Defined+Networks%3A+Architecture+and+Applications-p-978119857303) ↗ (https://www.wiley.com/en-us/Software+Defined+Networks%3A+Architecture+and+Applications-p-978119857303). Wiley. (ISBN: 978-1-119-85730-3)

Syllabus (Tentative)

Networking Basics

- Switching
- Addressing
- Routing

Switching Architecture

- Data, Control, and Management Planes
- Hardware Lookup
- Forwarding Rules
- Dynamic Forwarding Tables
- Autonomous Switches and Routers

SDN Architecture

- Plane Separation
- Simple Device and Centralized Control
- Network Automation and Virtualization
- Openness
- SDN Controllers: OpenDaylight and ONOS
- SDN Applications
- Northbound and Southbound APIs

OpenFlow

- Switch-Controller Interaction
- Flow Table
- Packet Matching
- Actions and Packet Forwarding
- Extensions and Limitations

Network Function Virtualization (NFV)

- SDN vs. NFV
- OPNFV

- Inline Network Functions
- Service Creation and Chaining
- NFV Orchestration

Emerging SDN Models

- Protocol Models: NETCONF, BGP, MPLS
- Controller Models
- Application Models: Proactive, Declarative, External
- SDN in Datacenters: Multitenancy, Failure Recovery
- SDN in Internet eXchange Points (IXPs)

SDN Ecosystem

- White-box switching
- Open Sourcing SDN
 - Open Networking Foundation
 - OpenDaylight
 - ONOS
 - OpenStack
 - OpenSwitch

Organization

- **Project** There will be a project to be done by each student. The project will involve development, testing, and reporting of an SDN application. Ideally, graduate students should pick an SDN application topic in their own domain of research. The project will require Mininet, or similar simulation/emulation environments depending on the appropriateness to the selected application topic. The students will be expected to write a report describing the design, implementation and testing of their prototyping efforts. Finally, the students will be required to present their project to their peers in the class.
- **Lab Exercises** There will be lab exercise approximately once in every two weeks. The exercises will provide an opportunity for the students to gain hands-on knowledge of SDN technologies and tools.
- **Homeworks** There will be homework assignments approximately once every week.
- **Discussions** Discussion topics will be posted every week and virtual participation required.
- **WebCourses** All course materials will be posted at the [WebCourses](#).
- **Academic Integrity and Professionalism** There will be no team projects or reports in this class, therefore all assignments and exams must be prepared strictly *individually*. Any form of cheating such as plagiarism or ghostwriting will incur a severe penalty, usually failure in the course. You are

allowed to discuss the course materials with your classmates or colleagues, but no written document, material or code can be shared with your classmates or colleagues. All work you submit must be your own scholarly and creative efforts. Please refer to the [UCF policy on rules of conduct](https://scai.sdes.ucf.edu/student-rules-of-conduct/) (<https://scai.sdes.ucf.edu/student-rules-of-conduct/>).

Lecture Capture Information

This course will utilize lecture capture with Panopto. All recorded lectures will be available via the Panopto Videos link in the course navigation menu. Please ensure that your computer meets the [minimum viewing requirements](https://support.panopto.com/articles/Documentation/viewing-requirements-2) (<https://support.panopto.com/articles/Documentation/viewing-requirements-2>). Contact [Webcourses@UCF Support](https://cdl.ucf.edu/support/webcourses/) (<https://cdl.ucf.edu/support/webcourses/>) if you need assistance with Panopto.

Grading (Tentative)

Grading Policy

Project will be 35% of the grade. Labs will be 30%, Homeworks will be 30% and Discussions will be 5%.

Project	35%
Lab Exercises	30%
Homeworks	30%
Discussions	5%

Grading Scale

94.5% - 100%	A
89.5% - 94.4%	A-
86.5% - 89.4%	B+
82.5% - 86.4%	B
79.5% - 82.4%	B-
73.5% - 79.4%	C+
68.5% - 73.4%	C

64.5% - 68.4% C-

54.5% - 64.4% D

0% - 54.4% F

Important Note:

Project final deliverable will not be accepted past the posted due date.

All other assignment submissions will not be accepted beyond two days after the deadline of the assignment. Late submissions within two days will be subject to points deduction as follows:

- 1 day late: 25% off (i.e., the assignment is graded out of 75 points)
- 2 days late: 50% off (i.e., the assignment is graded out of 50 points)

Re-grading requests can only be made within the first week after the graded assignments/tests are returned to the students.

Schedule (Tentative), Notes & Assignments



This is a tentative schedule. It is subject to readjustment depending on the time we actually spend in class covering the topics. Slides presented in class, Panopto video recordings, and assignments will be posted at the [WebCourses](#).

Date	Lectures	Assignments & Notes
Jan 8	Week 1: Introduction & Networking Basics	
Jan 15	Week 2: Networking Basics	
Jan 22	Week 3: Switching Architecture	GBC Chapter 1
Jan 29	Week 4: SDN Architecture	GBC Chapters 2 and 3
Feb 5	Week 5: SDN Architecture	GBC Chapter 4

Feb 12	Week 6: SDN Architecture	GBC Chapter 4
Feb 19	Week 7: OpenFlow	GBC Chapter 5
Feb 26	Week 8: OpenFlow	GBC Chapter 5
Mar 4	Week 9: NFV	GBC Chapter 10
Mar 11	Week 10: Emerging SDN Models	<i>GBC Chapter 7</i>
Mar 18	<i>Spring Break – NO CLASS</i>	
Mar 25	Week 11: Emerging SDN Models	GBC Chapters 8 and 9
Apr 1	Week 12: Emerging SDN Models	GBC Chapter 12
Apr 8	Week 13: SDN Ecosystem	GBC Chapters 11, 13, & 14
Apr 15	Week 14: SDN Futures	GBC Chapter 15 and other sources
Apr 22	Week 15: Project Presentations	

Acknowledgment

The materials for this course are in part based upon the materials from a number of people/sources, including:

- Official website for the Goransson, Black, & Culver text: [Software Defined Networks: A Comprehensive Approach](https://www.elsevier.com/books/software-defined-networks/goransson/978-0-12-804555-8)  (<https://www.elsevier.com/books/software-defined-networks/goransson/978-0-12-804555-8>)
- Official website for the Gray & Nadeau text: [Network Function Virtualization](https://www.elsevier.com/books/network-function-virtualization/gray/978-0-12-802119-4)  (<https://www.elsevier.com/books/network-function-virtualization/gray/978-0-12-802119-4>)
- Dr. Murat Yuksel, Professor, ECE, UCF

Responses to Academic Dishonesty, Plagiarism, or Cheating

Students should also familiarize themselves with the procedures for academic misconduct in UCF's student handbook, *The Golden Rule* < <https://goldenrule.sdes.ucf.edu/> (<<https://goldenrule.sdes.ucf.edu/>>). UCF faculty members have a responsibility for students' education and the value of a UCF degree, and so seek to prevent unethical behavior and respond to academic misconduct when necessary. Penalties for violating rules, policies, and instructions within this course can range from a zero on the exercise to an "F" letter grade in the course. In addition, an Academic Misconduct report could be filed with the Office of Student Conduct, which could lead to disciplinary warning, disciplinary probation, or deferred suspension or separation from the University through suspension, dismissal, or expulsion with the addition of a "Z" designation on one's transcript.

Being found in violation of academic conduct standards could result in a student having to disclose such behavior on a graduate school application, being removed from a leadership position within a student organization, the recipient of scholarships, participation in University activities such as study abroad, internships, etc.

Let's avoid all of this by demonstrating values of honesty, trust, and integrity. No grade is worth compromising your integrity and moving your moral compass. Stay true to doing the right thing: take the zero, not a shortcut.

Course Accessibility Statement

The University of Central Florida is committed to providing access and inclusion for all persons with disabilities. Students with disabilities who need access to course content due to course design limitations should contact the professor as soon as possible. Students should also connect with Student Accessibility Services (SAS) <<http://sas.sdes.ucf.edu/> (<<http://sas.sdes.ucf.edu/>>) (Ferrell Commons 185, sas@ucf.edu (<mailto:sas@ucf.edu>), phone 407-823-2371). For students connected with SAS, a Course Accessibility Letter may be created and sent to professors, which informs faculty of potential course access and accommodations that might be necessary and reasonable. Determining reasonable access and accommodations requires consideration of the course design, course learning objectives and the individual academic and course barriers experienced by the student. Further conversation with SAS, faculty and the student may be warranted to ensure an accessible course experience.

Campus Safety Statement

Emergencies on campus are rare, but if one should arise during class, everyone needs to work together. Students should be aware of their surroundings and familiar with some basic safety and security concepts.

- In case of an emergency, dial 911 for assistance.

Students who represent the university in an authorized event or activity (for example, student-athletes) and who are unable to meet a course deadline due to a conflict with that event must provide the instructor with documentation in advance to arrange a make-up. No penalty will be applied. For more information, see the UCF policy at <<https://policies.ucf.edu/documents/4-401.pdf> (<https://policies.ucf.edu/documents/4-401.pdf>)>

Religious Observances

Students must notify their instructor in advance if they intend to miss class for a religious observance. For more information, see the UCF policy at

<http://regulations.ucf.edu/chapter5/documents/5.020ReligiousObservancesFINALJan19.pdf>.