

Course Syllabus

TLEN 5410: Network Management and Automation Spring 2019 (11:00–12:15 p.m., Tues. & Thurs., Rm. ECEE 283, 3 Credits)

Course Description and Objectives

Students in this course should gain a much greater appreciation of the technologies and procedures required in managing, maintaining, and operating networks. The complex interactions among these aspects are shaping the future of this critical sector of network engineering. Topics will range from technical to soft skills and include best practices and the key theories behind them.

In TLEN 5410, students enforce the theoretical knowledge by incorporating hands-on labs about the technologies, services, and tools industry utilizes to manage and troubleshoot networks through the following key objectives:

- Understand the core technologies, theories, and dilemmas that face network engineers in this field.
- Understand common services needed for network functionality, maintenance, and troubleshooting such as SNMP, DHCP, IPv6, Autoconfiguration, NETCONF/YANG, SDN, and scripting/automation/DevOps technologies using Python, Ansible, Jinja2, Vagrant, etc.
- Learn current management suites utilized to manage networks, such as Amazon Web Services (AWS), and NMAP.
- Given the instructor's years of experience managing network operations and services in the telecommunications industry, engage in real-world discussions of the current controversies with implementing and troubleshooting networks.

TLEN 5410 covers these topics and achieves these objectives through hands-on lab exercises built around real-world applications and theories presented in the lectures. The course is split into the following units of study:

- Unit 1: Network Management
- Unit 2: Network Operations
- Unit 3: Automation & DevOps
- Unit 4: Network Design

Students successfully completing this course should gain a much greater appreciation of the technologies and procedures required in managing, maintaining, and operating networks. The complex interactions among these aspects are shaping the future of this critical sector of network engineering. The resulting understanding should enhance employment or promotion opportunities in the network engineering sector and enhance the student's ability to participate in the public discourse regarding the future of the network management and operations. By the end

of the course students will be competent in the technologies, services, and tools used to manage and troubleshoot complex networks.

Instructor

Dr. Levi Perigo

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Office Hours

Time: Tuesday/Thursday 9:00am-10:00am, and by appointment (scheduled via email)

Location: ECOT 312

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Course Prerequisites

Recommended:

- Data Communications
- Linux System Administration
- Fundamentals of Network Programming

Grading

Pop Quizzes, Discussions, and Class Participation	20%
Homework Labs and Assignments	50%
Midterm Exam	15%
Final Exam (practical & theory)	15%

To do well in this course, you will need to be prepared for each class by being ready to discuss and engage in critical thinking on issues covered in the readings. Be forewarned: pop quizzes will often be given at the start of class on the assigned reading material for the class.

All labs, homework, and assignments are due based on the due date in the syllabus. No exceptions to deadlines for course work will be made. Classroom absence may be permitted either for an emergency or prior notification to the professor stating the date and reason for the classroom absence two weeks in advance.

Grading Scale

100 – 93%	A
92 – 90%	A-
89 – 87%	B+
86 – 83%	B
82 – 80%	B-
79 – 77%	C+
76 – 71%	C
70 – 0%	C-

Class Readings

There is not a required textbook for the course. Students will be expected to have read the class readings noted in the course syllabus before attending the class.

RECOMMENDED BOOKS:

Clemm, Alexander. (2006). *Network Management Fundamentals*. ISBN-10: 1-58720-137-2

Chappell, L. (2013). *Wireshark 101: Essential Skills for Network Analysis (Wireshark Solutions)*. ISBN-10: 1-89393-972-3

Duffy, M. (2015). *DevOps Automation Cookbook*. ISBN-10: 1784392820

Odom, W. (2016). *CCENT/CCNA ICND1 100-105*. ISBN-10: 1-58720-580-7

Oppenheimer, P. (2011). *Top-Down Network Design*, Third Edition. ISBN-10: 1-58720-283-2

Many of the readings will be posted on the Canvas web site. To access Canvas, go to: <https://canvas.colorado.edu/>. You can login using your IdentityKey username and password. Once you login, click on the course name to go into the course¹.

Course Outline (Subject to Change)

Date	Topic, Reading, and/or Work Assignment
1/15/2019	Lecture: Introduction to Course & Network Engineering Review Reading: <ul style="list-style-type: none">• Chapter 1 (Clemm)• Chapters 0-5 (Chappell)• Basic Switching and Routing Understanding• Basic OSI Model Understanding Homework: <ul style="list-style-type: none">• Lab 0 (Not Graded) – VM Installation

¹ Please visit <https://canvas.colorado.edu/> to watch videos and learn more about using Canvas. If you run into any problems using Canvas, contact the help desk at: help@colorado.edu or at (303) 735-HELP.

	<ul style="list-style-type: none"> • Lab 0 (Not Graded) – GNS3 Setup
1/22/2019	<p>Lecture: Simple Network Management Protocol (SNMP)</p> <p>Reading:</p> <ul style="list-style-type: none"> • Chapters 6-8 (Clemm) <p>Reference Reading:</p> <ul style="list-style-type: none"> • <u>RFC 1157</u> <p>Homework:</p> <ul style="list-style-type: none"> • <u>Lab 1</u> – SNMP, TCPDUMP, & NMAP (Due 1/28) • <u>Assignment 1</u> (Due 1/28) – Write a one-page executive summary proposal evaluating two Network Management Systems (NMS). • Graded Discussions on CANVAS
1/29/2019	<p>Lecture: IPv6 Overview & Cloud Computing (AWS) (Note: IPv4 Addressing Lecture to be provided by SAs)</p> <p>Reading:</p> <ul style="list-style-type: none"> • <u>Cisco IPv6 Introduction</u>: Chapter 2 • ICND 1: Chapters 28-32 • <u>ADTRAN IPv6 Introduction</u>: Pages 1-9 • <u>Amazon Web Service (AWS)</u> • <u>PC Mag</u> – What is Cloud Computing? • Duffy – Chapter 11 <p>Homework:</p> <ul style="list-style-type: none"> • <u>Lab 2</u> – AWS (Due 2/4) • <u>Assignment 2</u> (Due 2/4) - Write a one-page executive summary on IPv4 to IPv6 transition mechanisms, and recommendations on best practice techniques to implement when transitioning from an IPv4 to IPv6 network. • Graded Discussions on Canvas
2/5/2019	<p>Lecture: Dynamic Host Configuration Protocol (DHCP) & IPv6 Autoconfiguration</p> <p>Reading:</p> <ul style="list-style-type: none"> • <u>ADTRAN DHCP</u>: Pages 1-4 • <u>ADTRAN DHCPv6</u>: Pages 1-11 • <u>Cisco DHCP</u>: Pages 65-67 • <u>Scapy</u> (for lab) <p>Reference Reading:</p> <ul style="list-style-type: none"> • RFC 2131 - <u>https://www.ietf.org/rfc/rfc2131.txt</u> • RFC 3315 - <u>https://www.ietf.org/rfc/rfc2131.txt</u> <p>Homework:</p> <ul style="list-style-type: none"> • <u>Lab 3</u> – DHCP (Due 2/11) • Graded Discussions on Canvas
2/12/2019	<p>Lecture: Software-Defined Networking (SDN)</p>

	<p>Reading:</p> <ul style="list-style-type: none"> • Feamster – Road to SDN (Canvas) • Cisco Whitepaper– SDN (Canvas) • Software Defined Networking – Cisco Edition (Canvas) – Chapter 1 • Open Networking Foundation (ONF) <p>Homework:</p> <ul style="list-style-type: none"> • <u>Lab 4</u> – Midterm Lab (2/25) • <u>Assignment 3</u> (Due 2/18) – Write a one-page executive summary about best practices when transitioning from a traditional network to a software-defined network. • Graded Discussions on Canvas
2/19/2019	<p>Midterm Review & Exam</p> <p>Homework:</p> <ul style="list-style-type: none"> • Graded Discussions on Canvas
2/26/2019	<p>Lecture: Network Automation with Python</p> <p>Reading:</p> <ul style="list-style-type: none"> • Network Automation: More than Scripting • Automating - Cisco • Paramiko.org • Paramiko GitHub • Trigger • Netmiko • NAPALM <p>Homework:</p> <ul style="list-style-type: none"> • <u>Lab 5</u> – Automation 1 (Due 3/4) • Graded Discussions on Canvas
3/5/2019	<p>Lecture: Network Automation and DevOps (1)</p> <p>Quiz: In-class Challenge</p> <p>Reading:</p> <ul style="list-style-type: none"> • Flask • Zero Touch Provisioning (ZTP) • Arista ZTP • Juniper ZTP • Cumulus ZTP <p>Homework:</p> <ul style="list-style-type: none"> • <u>Lab 6</u> – Automation 2 (Due 3/11) • <u>Assignment 4</u> (Due 3/18) – Write a one-page executive summary reviewing DevOps Automation tools: Ansible, Chef, Puppet, & Saltstack. • Graded Discussions on Canvas

3/12/2019	<p>Lecture: Network Automation and DevOps (2)</p> <p>Reading:</p> <ul style="list-style-type: none"> • <u>Ansible</u> • Duffy – Chapter 2, 5, & 7 <p>Homework:</p> <ul style="list-style-type: none"> • Lab 7 – Automation 3 - Ansible (Due 3/18) • Graded Discussions on Canvas
3/19/2019	<p>Lecture: Network Automation and DevOps</p> <p>Homework:</p> <ul style="list-style-type: none"> • Lab 8 – Automation 4 – Ansible, Jinja2, and Vagrant (Due 4/1) • Graded Discussions on Canvas
3/26/2019	No Class – Spring Break
4/2/2019	<p>Lecture: Network Automation</p> <p>Homework:</p> <ul style="list-style-type: none"> • Lab 9 – TBD
4/9/2019	<p>Lecture: Integrated Traffic Monitoring (ITM), NetFlow, & Network Configuration Protocol (NETCONF)/YANG</p> <p>Reading:</p> <ul style="list-style-type: none"> • <u>Integrated Traffic Monitoring</u> – Pages: 1-7 • <u>Netflow RFC</u> – Sections 1-2 • <u>Understanding NETCONF and YANG</u> – Network World • <u>Network Configuration Protocol RFC</u> – Section 1 • <u>YANG – A Data Modeling Language for NETCONF</u> – Section 1; 4.1-4.2.2 • <u>Overview of Network Management</u> • Creating the Programmable Network (Canvas) • <u>Cisco DevNet YDK-Py</u> <p>Homework:</p> <ul style="list-style-type: none"> • Lab 10 – NETCONF (Due 4/8) • Graded Discussions on Canvas

4/16/2019	<p>Lecture: Network Design</p> <p>Reading:</p> <ul style="list-style-type: none"> • Oppenheimer • <u>Cisco PPDIOO (1)</u> • <u>Cisco PPDIOO (2)</u> • Cisco Campus Wired LAN Design Guide (Canvas) <p>Recommended Videos:</p> <ul style="list-style-type: none"> • <u>Organizational and Technical Constraints</u> • <u>PPDIOO</u> • <u>Characterize the Network</u> <p>Homework:</p> <ul style="list-style-type: none"> • Lab 11 – Network Design Group Project (Due 4/15) • Graded Discussions on Canvas
4/23/2019	Lecture: Network Design Lab – Team Presentations (1 st Class) (2 nd Class – <i>Attend ITP Colloquium</i>)
4/30/2019	Final Review (1 st Class) & Final Quiz (Practical In-class Challenge) (2 nd Class)
5/7/2019 (See MyCUinfo)	Final Exam (Theory)

University Policies

Policy on Academic Honesty. All students of the University of Colorado at Boulder are responsible for knowing and adhering to the academic integrity policy of this institution. Violations of this policy may include: cheating, plagiarism, aid of academic dishonesty, fabrication, lying, bribery, and threatening behavior. All incidents of academic misconduct shall be reported to the Honor Code Council (honor@colorado.edu; 303-735-2273). Students who are found to be in violation of the academic integrity policy will be subject to both academic sanctions from the faculty member and non-academic sanctions (including but not limited to university probation, suspension, or expulsion). Other information on the Honor Code can be found at <http://www.colorado.edu/policies/honor.html> and at <http://honorcode.colorado.edu>

Religious Obligations. Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class, students with religious obligations that conflict with a test or other assignment should contact the instructor at least two weeks in advance to arrange an alternative time or assignment. See full details at http://www.colorado.edu/policies/fac_relig.html

Classroom and Course-Related Behavior. Students and faculty each have responsibility for maintaining an appropriate learning environment. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially

important with respect to individuals and topics dealing with differences of race, color, culture, religion, creed, politics, veteran's status, sexual orientation, gender, gender identity and gender expression, age, disability, and nationalities. Class rosters are provided to the instructor with the student's legal name. I will gladly honor your request to address you by an alternate name or gender pronoun. Please advise me of this preference early in the semester so that I may make appropriate changes to my records. See policies at <http://www.colorado.edu/policies/classbehavior.html> and at http://www.colorado.edu/studentaffairs/judicialaffairs/code.html#student_code

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Students with Disabilities. If you qualify for accommodations because of a disability, please submit to your professor a letter from Disability Services in a timely manner (for exam accommodations provide your letter at least one week prior to the exam) so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities. Contact Disability Services at 303-492-8671 or by e-mail at dsinfo@colorado.edu. If you have a temporary medical condition or injury, see Temporary Injuries under Quick Links at Disability Services website (<http://disabilityservices.colorado.edu/>) and discuss your needs with your professor.