The interdisciplinary telecom program (ITP) offers the core skills that allow students to master the latest technologies associated with aspects of Internet communications: technology, cybersecurity and policy (TCP). Further, students also develop aspects of the business skills and policy knowledge essential to achieving success in the companies driving today’s rapidly changing high-tech world. Within its core program ITP/TCP students should anticipate developing expertise in the growing areas of network engineering, cybersecurity, wireless communication, and telecommunications policy and strategy. As part of its core engagement and education the program continues to offer a multiplicity of rich opportunities for hands-on experience in its world-class labs equipped with state-of-the-art technologies.

ITP also offers graduate certificates, where students can gain foundational knowledge and skills focusing on a specific technology. Students also learn best practices and tools, methods and strategies that are immediately applicable to the work environment. Student should expect that graduate certificates aid the development or enhancement of a specialized expertise. ITP certificates also provide the flexibility to allow course credit hours to be applied toward an ITP master’s degree.

For more information, visit the Interdisciplinary Telecom Program (http://www.colorado.edu/itp) website.

Course code for this program is TLEN.

**Master’s Degree**

- Telecommunications - Master of Science (MS)  (catalog.colorado.edu/graduate/colleges-schools/engineering-applied-science/programs-study/telecommunications/telecommunications-master-science-ms)

- Telecommunications - Professional Master of Science (MST)  (catalog.colorado.edu/graduate/colleges-schools/engineering-applied-science/programs-study/telecommunications/telecommunications-professional-master-science-mst)

**Doctoral Degree**

- Telecommunications - Doctor of Philosophy (PhD)  (catalog.colorado.edu/graduate/colleges-schools/engineering-applied-science/programs-study/telecommunications/telecommunications-doctor-philosophy-phd)

**Certificates**

- Computer and Network Security - Graduate Certificate  (catalog.colorado.edu/graduate/colleges-schools/engineering-applied-science/programs-study/telecommunications/computer-network-security-graduate-certificate)

- Network Architecture - Graduate Certificate  (catalog.colorado.edu/graduate/colleges-schools/engineering-applied-science/programs-study/telecommunications/network-architecture-graduate-certificate)

- Telecom Policy and Strategy - Graduate Certificate  (catalog.colorado.edu/graduate/colleges-schools/engineering-applied-science/programs-study/telecommunications/telecommunications-policy-graduate-certificate)

- Wireless Networks and Technologies - Graduate Certificate  (catalog.colorado.edu/graduate/colleges-schools/engineering-applied-science/programs-study/telecommunications/wireless-networks-technologies-graduate-certificate)

**Faculty**

While many faculty teach both undergraduate and graduate students, some instruct students at the undergraduate level only. For more information, contact the faculty member’s home department.

- Chen, Lijun  (https://experts.colorado.edu/display/fisid_149472)
  Assistant Professor; PhD, California Institute of Technology

- Curry, James H.  (https://experts.colorado.edu/display/fisid_105730)
  Associate Faculty Director; PhD, University of California, Berkeley

- Gifford, Kevin K.  (https://experts.colorado.edu/display/fisid_104361)
  Scholar in Residence; PhD, University of Colorado Boulder

- Ha, Sangtae  (https://experts.colorado.edu/display/fisid_153246)
  Assistant Professor; PhD, North Carolina State University

- Massey, Daniel  (https://experts.colorado.edu/display/fisid_159491)
  Faculty Director; Professor; PhD, University of California, Los Angeles

- Perigo, Levi  (https://experts.colorado.edu/display/fisid_155562)
  Scholar in Residence; PhD, Nova Southeastern University

- Reed, David P.  (https://experts.colorado.edu/display/fisid_152458)
  Scholar in Residence, Faculty Director; PhD, Carnegie Mellon University

- Santos, Jose R.  (https://experts.colorado.edu/display/fisid_124623)
  Senior Instructor; MS, University of Colorado Boulder

- Thrall, Lloyd
  Scholar in Residence, Associate Faculty Director; MA, University of London (England)

**Courses**

**TLEN 5000 (3) Fundamentals of CyberSecurity for Leaders and Innovators**

Designed for students without a computer science background, this course introduces core concepts in cybersecurity including, confidentiality, authentication, risk management, and adversarial thinking. The concepts will be applied to both traditional information technology (IT) systems and cyber physical systems (CPS). At the conclusion of the course, students should have a solid foundation in cybersecurity and hands-on experience.

**Requisites:** Not open to Computer Science (CSCI) majors.

**Grading Basis:** Letter Grade

**TLEN 5106 (3) International Deployment of Broadband Networks**

Evaluates the business potential for deploying fixed or mobile broadcast networks in an international context. Guides students to develop financial statements to evaluate the investment potential of the venture. Covers: strategy, market potential, sales channels, costs, regulatory and financial issues all in an international context. Project teams mimic the matrix structure of working teams in business context and present to an investor their recommendations.

**Requisites:** Restricted to students with 87-180 credits (Senior) or graduate students in the College of Engineering or Leeds School of Business only.
TLEN 5150 (1) Managing Effectively in a Changing Telecommunications Environment
Provides students with an opportunity to join international managers and policy makers from around the world in an intensive seminar focused on the challenges of managing in a telecommunications environment in an era of technological change. Guest lecturers provide an effective overview of the cutting-edge issues managers face in telecom and technology companies around the world.
Equivalent - Duplicate Degree Credit Not Granted: ATLS 5150

TLEN 5190 (3) Standardization and Standards Wars
Examines current issues and strategy in the standardization of telecommunications and information technologies. Covers topics on the importance of standards, government and private sector perspectives, and impact of information age technologies on standards development. Introduces students to relevance of antitrust and intellectual property law to the topic.

TLEN 5245 (3) Introduction to Intellectual Property Law
Provides an overview of our nation's intellectual property laws, including patent, copyright, trademark, trade secret and also discusses other assorted matters related to intellectual property, including licensing, competition policy issues and remedies.
Equivalent - Duplicate Degree Credit Not Granted: LAWS 6301
Requisites: Restricted to CYBR/TLEN graduate students.

TLEN 5260 (3) Seminar: Law and Economics of the Information Age
Examines basic regulatory and legal challenges of our information economy and digital age. Emphasizes the "networked" information industries, the proper role of " unbundling" policies to advance competition and how intellectual property and antitrust rules should be developed.
Equivalent - Duplicate Degree Credit Not Granted: LAWS 8341
Requisites: Restricted to CYBR/TLEN graduate students.

TLEN 5265 (3) Copyright
Examines state and federal laws relating to the protection of works of authorship ranging from traditional works to computer programs. Studies the 1976 Copyright Act as well as relevant earlier acts. Gives attention to state laws, such as interference with contractual relations, the right of publicity, moral right, protection of ideas and misappropriation of trade values, that supplement federal copyright.
Equivalent - Duplicate Degree Credit Not Granted: LAWS 7301
Requisites: Restricted to CYBR/TLEN graduate students.

TLEN 5300 (1-3) Telecommunications Theory and Applications
Examines the mathematical and physical theory of telecommunications. Deals with the fundamental concepts related to a wide range of topics including physical units, numbering systems, trigonometric functions, logarithms, indices, decibels, complex numbers, calculus, elementary probability, and power circuit analysis.
Repeatable: Repeatable for up to 3.00 total credit hours. Allows multiple enrollment in term.

TLEN 5340 (3) VOIP Network Design
Focuses on VoIP network design and optimization. The emphasis is on the convergence of VoIP PSTN and cell phone networks and signaling. Topics include voice processing as well as IP and SS7 signaling. In addition there will be a review of ISDN, DSL, Sonet, ATM, SIP and MPLS. There will be a case problem for sizing a VoIP network using silence suppression.
Requisites: Requires corequisite of TLEN 5310. Restricted to TLEN or BUSN graduate students.

TLEN 5350 (3) Commercial Spaceflight Operations and Communications
Aimed at a high level fundamental understanding of broadcasting, communication and navigation satellite systems. Topics include orbital mechanics, orbit selection, spacecraft subsystems, spacecraft and earth station configurations, propagation issues, link budgets, modulation and multiplexing techniques, multiple access schemes (FDMA, TDMA, CDMA), error control coding, satellite network architecture, and economic, regulatory and business issues in Geo, Meo, and Leo systems.
Requisites: Requires corequisite of TLEN 5330. Restricted to graduate students in TLEN or BUSN.

TLEN 5430 (3) Data Communications 2
Provides a detailed technical study of Internet and Internet-related protocols following a top-down approach through the protocol stack. Bit-level analysis of a large number of Internet and Internet-related protocols, including the study of classic protocol suite principles. Covers real time and near real-time data streaming, IP mobility, IPv6, and an introduction to Internet security.
Requisites: Requires prerequisite course of TLEN 5330 or CSCI 4273 or CSCI 5273 (minimum grade D-). Restricted to TLEN or CSCI or BUSN grad students, or TLEN BS/MS students (C-AMENTLEN; C-CSCITLEN; C-CSENTLEN; C-ECENTLEN).

TLEN 5438 (3) Internet Lab
Have you ever wondered how the Internet actually works? This course teaches students simple, hands-on understanding of the technical components and challenges of providing Internet Services to everyday users. This is the ideal course for technical or non-technical students who have a passion for the Internet or need to have a more detailed understanding of the Internet within their career.
Grading Basis: Letter Grade

TLEN 5530 (3) Applied Network Security
Examines the critical aspects of network security. A technical discussion of threats, vulnerabilities, detection, and prevention is presented. Issues addressed are cryptography, firewalls, network protocols, intrusion detection, security architecture, security policy, forensic investigation, privacy, and the law.
Requisites: Restricted to CSCI juniors and seniors, or TLEN or CSEN graduate students, or TLEN BS/MS students (C-AMENTLEN; C-CSCITLEN; C-CSENTLEN; C-ECENTLEN).

TLEN 5540 (3) Network Security Laboratory
Applies what students have learned in computer and network security foundations in a simulated network environment. Topics to be covered include: system hardening, firewalls, intrusion detection, vulnerability assessment, and investigation.
Requisites: Restricted to CSCI juniors and seniors, or TLEN or CSEN graduate students, or TLEN BS/MS students (C-AMENTLEN; C-CSCITLEN; C-CSENTLEN; C-ECENTLEN).
Recommended: Prerequisite TLEN 5530 and operating system experience.

TLEN 5550 (3) Computer and Network Security
Studies methods to protect information, and the ability to process and move information, from theft, misuse, tampering, destruction and unauthorized access. Introduces foundational topics of computer and network security, including security models, cryptography and authentication protocols.
Equivalent - Duplicate Degree Credit Not Granted: CSCI 6268
Requisites: Restricted to Engineering Graduate Students and TLEN BS/MS students (C-AMENTLEN; C-CSCITLEN; C-CSENTLEN; C-ECENTLEN).
Recommended: Prerequisites CSCI 5273 and significant experience in coding (C or C++) and some experience in networks and familiarity with TCP/IP, UDP and ICMP.
TLEN 5700 (2) Research Methods
Develop basic concepts and methods for pursuing quantitative and qualitative research. Students will develop a research proposal that will be completed in TLEN 5710 or as a Master’s Thesis. Writing skills test required.

Requisites: Restricted to CYBR or BUSN graduate Students

TLEN 5710 (1-3) Capstone
Complete Capstone research project initiated in TLEN 5700.

Repeatable: Repeatable for up to 3.00 total credit hours.

Requisites: Requires prerequisite course of TLEN 5700. Restricted to TLEN or BUSN graduate students only.

TLEN 5841 (3) Secure Web Application Development
Learn to develop and protect secure applications for web and mobile. Students will develop in a production cloud environment mirroring industry trends. Techniques to resist attackers and increase situational awareness will be covered. The class culminates with an end of semester project applying secure coding techniques to build a secure web application from start to finish.

Requisites: Restricted to CSCI juniors and seniors, or TLEN or CSEN graduate students, or TLEN BS/MS students (C-AMENTLEN; C-CSCITLEN; C-CSENTLEN; C-ECENTLEN).

Grading Basis: Letter Grade

TLEN 5842 (3) Linux Systems Administration
Introduces Linux system administration and related topics, including trouble-shooting system and network problems, hardware and software configuration and installation, basic scripting, and security aspects of internet hosts. Students build Linux servers from the ground up, using provided computing resources, and must maintain and secure the servers themselves.

Requisites: Restricted to CSEN or TLEN graduate students or TLEN BS/MS students only.

Grading Basis: Letter Grade

TLEN 6438 (3) Internet Lab 2
Builds on TLEN 5438 Internet Lab, and teaches students simple, hands-on understanding of the technical components and challenges of providing Internet Services to everyday users. This is the ideal course for students with a basic foundation of technology who have a passion for the Internet or need to have a more detailed understanding of network security and wireless networks within their career.

Requisites: Requires prerequisite TLEN 5438 (minimum grade B-).

Grading Basis: Letter Grade

TLEN 7000 (1-6) Current Topics in Telecommunications
Studies research topics of current interest in telecommunication and networking.

Repeatable: Repeatable for up to 8.00 total credit hours.

Requisites: Restricted to CYBR/TLEN graduate students.

TLEN 7001 (3) Interdisciplinary Telecom Analysis
Examines a set of problems, research methodologies and analytical techniques that are common to the research, problem solving and analysis of information and communications technology development and deployment issues. Looks critically at the strengths, limitations and underlying assumptions of key research and analysis approaches that relate business, economic and policy objectives to current and future telecommunications development and deployment efforts.

Requisites: Restricted to CYBR/TLEN graduate students.

Grading Basis: Letter Grade