Telecommunication Systems (TELE)

TELE 5330. Data Networking. (4 Hours)
Provides the basics of data networking protocols and architectures. Topics include protocol architecture of the internet; application protocols such as FTP, SMTP and HTTP, web caching, DNS, CDNs, and P2P applications; use of TCP and UDP socket programming to develop network applications in Python; transport protocols, including TCP, UDP, and TCP congestion control; IP protocol, addressing, IPv4 and v6, NATs, ICMP, and tunnels; routing algorithms and OSPF; data link protocols, encoding, framing, error control, and PPP; switched LANs, ARP, Ethernet, and VLANs; wireless LANs and 802.11 protocols; and network security—encryption, message integrity, authentication protocols, key management, SSL/TLS, IPsec, and 802.11i.

Corequisite(s): TELE 5331

TELE 5331. Lab for TELE 5330. (0 Hours)
Addresses a range of networking components, including routers, switches, and Linux servers, and how they are configured to create a virtual environment. Covers the installation and configuration of networking concepts such as DNS, DHCP, and firewalls and the creation of virtual environments. Requires students, working in teams, to configure one or more components; the teams then must interconnect the components to form a small network. In the process of configuration and integration, students are exposed to troubleshooting at various protocol layers and have an opportunity to become familiarized with different operating systems and networking tools.

Corequisite(s): TELE 5330

TELE 5340. Telecommunications Public Policy and Business Management. (4 Hours)
Introduces students to business management issues, such as basic accounting, finance, marketing, and operations in the telecommunications field, and also topics such as the time value of money and decision making. Also includes issues of human relations, organizational behavior, and business strategy. Provides an understanding of the regulatory environment of the telecommunications industry. Topics include universal service, service quality tariffs, the Modified Final Judgment and Telecom Act of 1996, market restrictions and segmentation, the current competitive environment in the United States and internationally, interconnection including unbundling, collocation, economic issues, and global trends in market reform.

TELE 5350. Telecom and Network Infrastructure. (4 Hours)
Provides in-depth treatment of the wireline and wireless infrastructure of the network supporting all telecommunication, internet, and enterprise applications. Covers the basics of communications—source coding, baseband and broadband modulation and transmission, channel coding, spread-spectrum, multiuser radio communications, radio link analysis, and propagation. Also covers the wireline core network—digital and optical transmission, framing, network synchronization, asynchronous and synchronous multiplexing, cross connects, SONET/SDH, DWDM, OTN, protection switching, and network availability. Addresses wireline (DSL, digital cable, FTTx, PONs) and wireless access (cellular, Wi-Fi), frequency reuse, and handoff. Also addresses support of data transport (switched Ethernet, VLAN, IP, MPLS) and application networks (PSTN, mobile core, internet, IPTV, and virtual networks).

Prerequisite(s): TELE 5330 (may be taken concurrently) with a minimum grade of B- or TELE 5330 (may be taken concurrently) with a minimum grade of B-

TELE 5360. Internet Protocols and Architecture. (4 Hours)
Offers in-depth treatment of protocols used in the internet, wireless access, and enterprise networks. Topics include protocols for network layer QoS (including DiffServ, ECN, RSVP, MPLS); protocols for security, including both access control and network-level security (e.g., X.509, SSL/TLS, IPsec, IKE, EAP); protocols for interdomain routing (BGP); protocols to support multicast, broadcast, and streaming applications; protocols to support host mobility, large server deployments, content distribution, and enterprise networks (VLANs, etc); and protocols to support IPv6 (e.g., address assignment) and its interoperability with IPv4. Also covers network design architectures for cloud computing, data centers, content distribution, layer-2 networks, etc. Discusses general scaling issues for large networks.

Prerequisite(s): TELE 5330 with a minimum grade of B- or TELE 5330 with a minimum grade of B-

TELE 5600. Linux/UNIX Systems Management for Network Engineers. (4 Hours)
Introduces UNIX/Linux in a networking/Internet environment. Covers operating system concepts, tools, and utilities; networking and security issues; and data and text processing using scripts and filters. Addresses basic administrative tasks such as managing users, file systems, security, and software. Covers networking topics such as network configuration, daemon processes, SSH, DNS, DHCP, diagnostic tools, and the use of scripts and automation to manage applications and systems, as well as security topics such as name and authentication services, access control lists, file modification protections, and firewalls.

TELE 5976. Directed Study. (1-4 Hours)
Offers independent work under the direction of members of the department on a chosen topic. Course content depends on instructor. May be repeated without limit.

TELE 6100. Mobile Wireless Communications and Networking. (4 Hours)
Studies communications and networking issues in providing broadband wireless access to mobile applications. Discusses networking technologies required by converged IP-based applications. Covers converged network architectures and the interworking of different generations of access technologies with the Evolved Packet Core (EPC). Registration limited and by application only; it is expected that all students have prior knowledge of digital communications, radio propagation, cellular networks, and second-generation wireless standards.

Prerequisite(s): TELE 5330 with a minimum grade of B- or TELE 5330 with a minimum grade of B-

TELE 6300. Communication and Network Security. (4 Hours)
Studies the skills necessary to apply and implement network and communication security in enterprise environments. Covers various concepts related to computer security and network protection. Explores systems security, access control, network infrastructure, assessments and audits, cryptography, and organizational security, all of which help to protect enterprise networks' confidentiality, integrity, and availability. Covers common network attacks, cryptography basics, computer forensics, and operational/organizational security related to physical security, disaster recovery, and business continuity. Discusses recent trends in network security attacks and cyberattacks, analyzing worms and trojans, SSL/TLS session renegotiations/compression, DNS security, spam, and crypto-based countermeasures.

TELE 6350. Unified Communications and Collaboration. (4 Hours)
Explores the technologies that underlie unified communications and collaboration (UCC) applications and communications networks. With the migration of communications infrastructure to the cloud, a democratization of communications is underway that allows customers to build powerful UCC applications on top of networks managed by service providers. UCC applications integrate audio and video conferencing, messaging, virtual whiteboards, and enhanced call control capabilities. Major topics include architecture of communication networks, IP-based voice, video and messaging protocols, public cloud-based communications, browser-based communications, and Communications Platforms-as-a-Service (CPaaS). Uses class projects to offer students an opportunity to get hands-on experience in addressing real-world problems in UCC communications infrastructure, services, and applications.

Prerequisite(s): TELE 5330 with a minimum grade of B- ; TELE 5600 with a minimum grade of B-

TELE 6400. Software-Defined Networking. (4 Hours)
Introduces the foundational theories and technologies of software-defined networking (SDN), a new paradigm in computer networking that allows a logically centralized software program to control the behavior of an entire physical network. Discusses SDN technologies, such as the OpenFlow specification and OpenDaylight controller, and introduces students to SDN applications and network function virtualization (NFV). Offers hands-on exposure to popular open-source software and technologies through student projects. Requires good knowledge of Java or Python.

Prerequisite(s): TELE 5330 with a minimum grade of B- or TELE 5330 with a minimum grade of B-

TELE 6420. Infrastructure Automation Design and Tools. (4 Hours)
Exposes students to best practices for infrastructure automation, which is highly critical in the design and deployment of network and server infrastructure that supports microservices architecture applications on public cloud (IaaS) services. Provides hands-on experience with IaC (infrastructure as code) technologies for provisioning and deprovisioning, configuration, patching, security, monitoring, alerting, logging, etc., for infrastructure components ranging from network devices to servers to entire virtual data centers. Focuses on both individual and team projects involving the use of IaC tools such as Ansible, Puppet, Git, Selenium, Netmiko, Paramiko, CFEngine, Docker, and Kubernetes for infrastructure deployment and automation.

Prerequisite(s): TELE 5330 with a minimum grade of B- or TELE 5330 with a minimum grade of B-

TELE 6500. Machine Learning for IoT Systems. (4 Hours)
Studies the design, development, rollout, and maintenance of machine learning algorithms for IoT systems, which generate and process time series data under memory and timeliness constraints. Focuses on verticals like Industry 4.0, wearables, and smart grids/homes. Explores the nuances of handling IoT time series data in both edge and cloud computing settings including the preparation, exploration, and feature engineering for sensor data. Covers domain-specific problem classes like forecasting, change point detection, and temporal anomaly detection. Addresses customized performance metrics for time series algorithms. Analyzes deep learning architectures for time series problems using TinyML for embedded devices. Course projects focus on time series, going beyond traditional datasets used in conventional ML classes.

TELE 6510. Fundamentals of the Internet of Things. (4 Hours)
Explores the foundations of and technologies involved in the Internet of Things (IoT). Topics include machine-to-machine (M2M) communications and its relationship with IoT. Examines fundamental components of the IoT architecture reviewing industry standards. Presents a large array of case studies. Discusses the fundamentals of data networks with a focus on different wireless technologies relevant to IoT, including the latest developments in IEEE 802.11, IEEE 802.15.4, and BLE, as well as network layer protocols such as 6LoWPAN that are critical to the deployment of wireless IoT networks. Discusses a range of IoT application protocols, especially MQTT, CoAP, and AMQP. Also explores IoT security and privacy considerations and identification mechanisms for IoT devices. Introduces wireless sensor networks and routing protocols for wireless networks.

TELE 6530. Connected Devices. (4 Hours)
Offers an in-depth, software-intensive exploration of the Internet of Things (IoT)—from device to cloud—culminating in a semester-long project where each student designs, builds, and presents an end-to-end, integrated IoT solution. Covers IoT concepts and architectures, and incorporates significant software development activities through weekly modules. Includes testing, DevOps, and messaging protocols specific to the IoT; device integration; and cloud services designed for IoT ecosystems.

TELE 6550. IoT Embedded System Design. (4 Hours)
Explores the technologies and techniques behind the field of design and development of modern embedded devices in IoT systems. Specifically, focuses on a hands-on approach to software development on an embedded hardware platform. Through a final project, students have an opportunity to build and deploy an industrial-grade state-of-the-art embedded IoT solution. Presents C coding, but also reviews the ARM ISA as well as C++ development and debugging. Applies theoretical concepts to practical issues including pipelining, parallelism, concurrency, memory architectures, and I/O (GPIO, I2C, UART, SPI). Introduces bare-metal and OS-based development focusing on multitasking, scheduling, interrupts, threads, processes, tasks, IPC, drivers, contention resolution, and shared memory. Introduces state-of-the-art Google Cloud IoT and FreeRTOS APIs.

TELE 6962. Elective. (1-4 Hours)
Offers elective credit for courses taken at other academic institutions. May be repeated without limit.

TELE 6973. Special Topics—Networking. (1-4 Hours)
Offers topics of current interest in Networking. May be repeated seven times for a maximum of 8 total semester hours.

TELE 7374. Special Topics in the Internet of Things. (4 Hours)
Offers topics of current interest in the Internet of Things. Topics vary from semester to semester. May be repeated without limit.

TELE 7945. Master's Project. (4 Hours)
Supports a project in cyber-physical systems and the Internet of Things that may have both hardware and software elements. Project to be carried out under faculty supervision.

TELE 7976. Directed Study. (1-4 Hours)
Offers theoretical or experimental work under the direction of members of the department on a chosen topic. Course content depends on instructor. May be repeated up to seven times for a maximum of 8 semester hours.

TELE 7986. Research. (0 Hours)
Offers students an opportunity to conduct full-time research under faculty supervision.

TELE 7990. Thesis. (4 Hours)
Offers students an opportunity to conduct theoretical and experimental work under the supervision of a departmental faculty.

Prerequisite(s): TELE 7945 with a minimum grade of C-