TELECOMMUNICATIONS (TCOM)

500 Level Courses

TCOM 500: Modern Telecommunications. 3 credits.
Comprehensive overview of telecommunications, including current status and future directions. Topics include review of evolution of telecommunications; voice and data services; basics of signals and noise, digital transmission, network architecture and protocols; local area, metropolitan and wide area networks and narrow band ISDN; asynchronous transfer mode and broadband ISDN; and satellite systems, optical communications, cellular radio, personal communication systems, and multimedia services. Examples of real-life networks illustrate basic concepts and offer further insight. Offered by Electrical & Computer Engineer. May not be repeated for credit.

Recommended Prerequisite: TCOM 575, or equivalent.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture

TCOM 505: Networked Multicomputer Systems. 1.5 credit.
Introduces systems engineering of a networked multicomputer system. Studies distributed multicomputer architectures, architecture of a network operating system, and key system components. The focus of this course is on the development of a thin client/server system, requirements analysis of a client/server web computing, system planning and implementation. Includes a study of example multicomputer systems and a discussion of future directions. Offered by Electrical & Computer Engineer. May not be repeated for credit.

Recommended Prerequisite: TCOM 500, 530, or equivalent.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture

TCOM 510: Client-Server Architectures and Applications. 1.5 credit.
Fundamentals of application engineering for Client/Server (C/S) Internet environments. Review of C/S application architectures and system perspective on C/S middleware. Study of web-based middleware, distributed data managers and SQL middleware, distributed transaction processing middleware, and C/S object technology. Offered by Electrical & Computer Engineer. May not be repeated for credit.

Recommended Prerequisite: TCOM 500 or ECE 540.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture

TCOM 514: Basic Switching: Lecture and Laboratory Course. 3 credits.
Basic switching techniques and protocols for low and high-speed digital packet networks (Ethernet, Frame Relay, ATM, X.25) are taught within a half semester lecture series, followed by hands-on laboratory for remainder of semester. Real-life scenarios taught in the laboratory element through exercises that involve configuring switches and routers. Offered by Electrical & Computer Engineer. May not be repeated for credit.

Recommended Prerequisite: TCOM 500, 511, 551, and 552 or equivalent.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture

TCOM 530: Personal Communication Systems (PCS). 1.5 credit.
Introduces Personal Communication Systems (PCS). Topics include multiple technical layers of the PCS systems; data link level and network layer protocols, including implementation; mobile station operation and base station operation; and how voice and data services work. Also discusses vital issues of user authentication, privacy, and data or voice encryption. Offered by Electrical & Computer Engineer. May not be repeated for credit.

Recommended Prerequisite: TCOM 500, 501, 551, and 552 or equivalent.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture
Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Laboratory, Lecture

**TCOM 515: Internet Protocol Routing: Lecture and Laboratory Course.** 3 credits.
Internet Protocol (IP) routing overview; static routing; dynamic routing; default routing; access lists; route redistribution; RIP, OSPF, IGRP, EIGRP, IS-IS, and BGP protocols submitted for comment. Real-life scenarios taught in laboratory element through exercises that involve configuring routers as network elements. Offered by Electrical & Computer Engineer. May not be repeated for credit.

**Recommended Prerequisite:** TCOM 535.

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Laboratory, Lecture

**TCOM 518: Third Generation Cellular Telephony.** 1.5 credit.
Introduction to post-second generation cellular systems; benefits and features of third generation (3G) systems; review of air interface standards currently approved for 3G; review of 3G technologies; analysis of competing multiple access methods; transition plans and backward compatibility between 2G, 21/2G, and 3G systems; possible fallback plans. Offered by Electrical & Computer Engineer. May not be repeated for credit.

**Recommended Prerequisite:** TCOM 506, 551, and 552.

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture

**TCOM 520: Economics of Telecommunications.** 3 credits.
Management of telecommunications networks; economic concepts in changing climate of telecommunications ownership; deregulation, and privatization; resource allocation fundamentals based on internal rate-of-return, net present value, opportunity costs; valuation of potential acquisitions in broad telecommunications market; financial modeling techniques. Offered by Electrical & Computer Engineer. May not be repeated for credit.

**Recommended Prerequisite:** TCOM 500

**Recommended Corequisite:** TCOM 521.

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture

**TCOM 521: Systems Engineering for Telecommunications Management.** 3 credits.
Advanced software principles, techniques, and processes for designing and implementing complex telecommunication systems. Planning and implementation of telecommunications systems from strategic planning through requirements, initial analysis, general feasibility study, structured analysis, detailed analysis, logical design, and implementation. Current system documentation through use of classical and structured tools and techniques for describing flows, data flows, data structures, file designs, input and output designs, and program specifications. Practical experience gained through project. Offered by Electrical & Computer Engineer. May not be repeated for credit.

**Recommended Prerequisite:** TCOM 500.

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture

**TCOM 530: Data Communications Fundamentals.** 3 credits.
Covers the foundations of modern data communications. The lower layers of the OSI reference model are discussed with an emphasis on the data link and the network layers. Concepts are illustrated by drawing examples from important data networks ranging from local area networks to the Internet. Offered by Electrical & Computer Engineer. May not be repeated for credit.

**Recommended Prerequisite:** TCOM 500

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture
TCOM 535: The TCP/IP Suite of Internet Protocols. 3 credits.
Provides an in-depth treatment of the protocols that define the Internet.
Topics include: IPv4 addressing and subnetting; CIDR; Data Link
Protocols: ARP, RARP; Network Protocols: IP, ICMP; IP Routing Protocols:
RIP, OSPF, IS-IS, BGP; Transport Protocols: TCP, UDP; TCP Features:
Windowing, Congestion Control, Advanced Protocols: MPLS; Internet
Security: IPsec, SSL. Offered by Electrical & Computer Engineer. May be
repeated within the degree.

Recommended Prerequisite: TCOM 530.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy,
Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level
students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of
Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture

TCOM 542: Stochastic Models in Telecommunications. 1.5 credit.
Review of teletraffic theory: Erlang’s loss formula, equivalent random
method, delay and delay-loss systems; complex simulation modeling
and statistical analysis of outputs. Parameter estimation, evaluation of
quality. Offered by Electrical & Computer Engineer. May not be repeated for
credit.

Recommended Prerequisite: TCOM 500.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy,
Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level
students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of
Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture

TCOM 544: Reliability and Maintainability of Networks. 3 credits.
Stochastic modeling of network reliability, simulation modeling, modeling
replacement strategies. Introduces quality control, sampling for
acceptance, economic design of quality control systems, and system
reliability. Also covers faulty tree analysis, life testing, repairable systems
and role of reliability, quality, and maintainability in life-cycle costing.
Offered by Electrical & Computer Engineer. May not be repeated for
credit.

Recommended Prerequisite: TCOM 500.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy,
Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level
students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of
Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture

TCOM 547: Project Management in Telecommunications. 3 credits.
Develops integrated approach to managing major telecommunications
project; evaluates and uses tools and software for project management,
with specific goals of containing costs and time overruns; introduces elements for resolving conflict resolution and applying motivation
within project team, and gaining the ability to monitor and control projects in changing environment; develops understanding of unique attributes of major telecommunications systems such as interoperability
requirements and international technical standards. Offered by Electrical
& Computer Engineer. May not be repeated for credit.

Recommended Prerequisite: TCOM 500.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy,
Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level
students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of
Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture

TCOM 551: Digital Communication Systems. 3 credits.
Digital transmission of data, voice, and video. Covers signal digitization;
modulation and demodulation; error correction coding; multiple access
methods; multiplexing; synchronization; channel equalization; frequency
spreading; encryption; transmission codes; digital transmission using
bandwidth compression techniques; elements of information theory;
and development of link budget evaluation such as system noise
temperature, Nyquist filter concepts, antenna gain, and filter bandwidth.
Offered by Electrical & Computer Engineer. May not be repeated for
credit.

Recommended Prerequisite: TCOM 500.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy,
Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level
students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of
Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture

TCOM 552: Introduction to Mobile Communications Systems. 3 credits.
Introduces mobile communication system design and analysis. Topics
include mobile communication channel, access and mobility control,
mobile network architectures, connection to fixed network, and signaling
protocols for mobile communication systems. Offers examples of mobile
communication systems including panEuropean GSM system, North
American DAMPS system, and Personal Communication Systems.
Offered by Electrical & Computer Engineer. May not be repeated for credit.

**Recommended Prerequisite:** TCOM 500, TCOM 551.

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture

**TCOM 555: Network Management Foundations and Applications.** 3 credits.
Defines and explains techniques that network managers utilize to maintain and improve performance of telecommunications network; network management system; five tasks traditionally involved with network management (fault management, configuration management, performance management, security management, and accounting management); theoretical background in transmission systems sufficient to understand network parameters such as capacity and response times; and specific network management products. Also explores how network performance data should be used for management and when considering upgrades in network architecture. Offered by Electrical & Computer Engineer. May not be repeated for credit.

**Recommended Prerequisite:** TCOM 500 and TCOM 530.

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture

**TCOM 561: Security, Privacy, and Applied Cryptography for Telecommunications.** 3 credits.
Presents on introductions to Computer and Network Security and Privacy; Digital Threats; Authentication Techniques; Vulnerabilities; Integrity; Access Control; Threat Modeling and Risk Assessment; Security Policies and Countermeasures; Cryptography; Block Ciphers and DES; AES; Cipher Block Operation; Certificate and Credentials; Public Key Cryptography and RSA; Key Management; Digital Signature; Electronic Mail Security; IP Security. Offered by Electrical & Computer Engineer. May not be repeated for credit.

**Recommended Prerequisite:** TCOM 500 and TCOM 530.

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture

**TCOM 562: Network Security Fundamentals.** 3 credits.
Introduces full spectrum of network security. Topics include taxonomy such as language commonality in incident handling, national strategy to secure cyberspace, and cybersecurity organizations; organizational structure for network defense; best practices, security policy, and threats; actors and tools, countermeasures, vulnerability identification/correction, intrusion detection, and impact assessment; firewalls and intrusion detection systems; antivirus software; active defense; disaster recovery; and law enforcement and privacy issues. Reviews threats and vulnerabilities in network systems based on reports, case studies available in the literature, and actual experience. Offered by Electrical & Computer Engineer. May not be repeated for credit.

**Recommended Prerequisite:** TCOM 500.

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture

**TCOM 575: Quantitative Foundations for Telecommunications.** 3 credits.
Provides quantitative foundations in mathematical and electrical concepts to permit registration for courses in telecommunications MS degree and certificate programs. Topics include polynomials, exponentials, linear and quadratic equations, graphs and functions, trigonometric functions, radial measure and sine/cosine functions, exponentials and logarithms, basic probability and statistics, fundamentals of matrix algebra and vectors, basic Boolean logic; circuit elements (resistor, capacitor, inductor), basic electrical circuits, units, Ohm's law, Kirchhoff's law, decibel notation. Notes: Course cannot be used for credit in any IT&E graduate degree program. Offered by Electrical & Computer Engineer. May not be repeated for credit.

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture
Students in a Non-Degree Undergraduate degree may not enroll. Enrollment is limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture

**Recommended Prerequisite:** TCOM 552.

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture

**Recommended Prerequisite:** TCOM 551.

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture

**Recommended Prerequisite:** TCOM 552.

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture

**Recommended Prerequisite:** TCOM 551.

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture

**Recommended Prerequisite:** TCOM 552.
Resonators; Photons and Matter, Lasers, Photons in Semiconductors; Semiconductor Photon Sources and Detectors; Light Emitting Diodes; Modulation of Optical Signals; Optoelectronic Networks; FDDI, Fiber channel, SONET, SDH, Ethernet on Optical Networks; Wavelength Division Multiplexing (WDM) networks; Basics of Fiber Optic System Design. Offered by Electrical & Computer Engineer. May not be repeated for credit.

**Recommended Prerequisite:** TCOM 500.

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture

TCOM 609: **Interior Gateway Protocol (IGP) Routing.** 3 credits.
Discusses development of Interior Gateway Protocols, including standards documents; interaction between various interior and exterior gateway protocols; design procedures and implementation aspects; field trial issues; and analysis of latest RFC information posted on IETF web site. Offered by Electrical & Computer Engineer. May not be repeated for credit.

**Recommended Prerequisite:** TCOM 515 and TCOM 535, or equivalent.

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture

TCOM 610: **Border Gateway Protocol (BGP) Routing.** 3 credits.
Discusses development of Border Gateway Protocol and its application in today's Internet routing architecture. Covers evolution of Internet, BGP routing standard specifications (RFCs), interaction between various routing protocols, network BGP routing design principals and procedures for enterprise and ISP networks, BGP's real-world implementation and configuration syntax, network scalability and convergence issues, and the latest extension and proposals for new standards. Offered by Electrical & Computer Engineer. May not be repeated for credit.

**Recommended Prerequisite:** TCOM 509 and TCOM 515, or equivalent.

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture

TCOM 611: **Multi-Protocol Label Switching (MPLS).** 3 credits.
Develops full understanding of Multi-Protocol Label Switching (MPLS) theory, technology, and implementation aspects through detailed analysis of MPLS routing concepts and protocol stacks, and completion of major project to reinforce understanding of MPLS. Offered by Electrical & Computer Engineer. May not be repeated for credit.

**Recommended Prerequisite:** TCOM 609 or 610

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture

TCOM 631: **Voice Over IP.** 3 credits.
Presents the protocols used for transporting voice over Packet Switched Network. Topics include: Signaling basics; Topics; VoIP Network Scenarios and Connection Strategies; Communication Protocols: RTP, RTCP; VoIP Decomposition; Performance and quality metrics for VoIP; VoIP Signaling Protocols: H.323, SIP, SS7; Softswitches: architecture, functionality, application; VOIP-PSTN integration and migration; VOIP Quality and QoS; VoIP Security: Vulnerabilities, remedies; NextGen VoIP: VoIP Mobility, Equipment, Voice XML, IMS; Future of VoIP. Offered by Electrical & Computer Engineer. May not be repeated for credit.

**Recommended Prerequisite:** TCOM 535

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture

TCOM 653: **Global Positioning System (GPS).** 3 credits.
Presents in-depth treatment of theoretical and practical aspects of the Global Positioning system. Topics include: Basic Transmission Engineering for GPS, Spaced-Based Systems, Navigation, GPS Architecture, Signals, Ranging; Sources of Ranging Errors, Atomic Clocks, Timescales, Frequency Stability, Time Distribution, Carrier-to-Noise Ratio (C/No), Noise Figure and Noise Factor, Code and Signal Generation. Signal Acquisition and Tracking, Modulation/Demodulation, Correlation, Time-To-First-Fix, Almanac and Dual-Frequency Capability; Differential
Students in a Non-Degree Undergraduate degree may enroll.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture

TCOM 660: Network Forensics. 3 credits.
Deals with collection, preservation, and analysis of network-generated digital evidence so it can be successfully presented in civil or criminal court of law. Examines relevant federal laws and private sector applications. Examines capture/intercept of digital evidence, analysis of audit trails, recordation of running processes, and reporting of such information. Offered by Electrical & Computer Engineer. May not be repeated for credit. Equivalent to CFRS 660.

Recommended Prerequisite: TCOM 500, and working knowledge of computer programming.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture

TCOM 661: Digital Media Forensics. 3 credits.
Deals with collection, preservation, and analysis of digital media so this evidence can be successfully presented in civil or criminal court of law. Examines relevant federal laws and private sector applications. Examines seizure, preservation, and analysis of digital media. Offered by Electrical & Computer Engineer. May not be repeated for credit. Equivalent to CFRS 661.

Recommended Prerequisite: TCOM 548 and 556, or TCOM 562, and working knowledge of computer operating systems; or permission of instructor.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture

TCOM 662: Advanced Secure Networking. 3 credits.
Advanced technologies in network security that can be applied to enhance enterprise and ISP’s network security. Covers network perimeter defense concept and various components for complete layered defense system. Examines each component and its technologies, including TCP/IP protocol vulnerabilities, router access control list (ACL), dynamic ACL, firewall, network address translation (NAT), virtual private network (VPN), IPSec tunnels, intrusion detection system (IDS), routing protocol security, denial-of-service (DOS) attack, DOS detection and mitigation techniques. Offered by Electrical & Computer Engineer. May not be repeated for credit.

Recommended Prerequisite: TCOM 535 and TCOM 562, and a working knowledge of network routing protocols.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture

TCOM 663: Operations of Intrusion Detection and Forensics. 3 credits.
Introduces students to network and computer intrusion detection and its relation to forensics. It addresses intrusion detection architecture, system types, packet analysis, and products. It also presents advanced intrusion detection topics such as intrusion prevention and active response, decoy systems, alert correlation, data mining, and proactive forensics. Offered by Electrical & Computer Engineer. May not be repeated for credit. Equivalent to CFRS 663.

Recommended Prerequisite: TCOM 535 and a working knowledge of computer programming.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

Schedule Type: Lecture

TCOM 664: Incident Response Forensics. 3 credits.
This course addresses incident detection, response, and those aspects of computer forensics pertinent to the investigation of trade secret theft, economic espionage, copyright infringement, piracy, and fraud. Procedures for gathering, preserving, and analyzing forensic evidence are discussed in detail and are applied to both computer and network operations.

Recommended Prerequisite: TCOM 535 and a working knowledge of computer programming.
Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment is limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Recommended Prerequisite:** Permission of instructor; specific prerequisites vary.

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment is limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture

**TCOM 690: Advanced Topics in Telecommunications.** 3 credits.
Advanced topics from recent developments and applications in various engineering disciplines in specialty modules 1, 2, and 3 of TCOM program. Advanced topics chosen so that they do not duplicate existing TCOM courses. Active participation of students encouraged in form of writing and presenting papers in various research areas of advanced topic. Enhances professional engineering community's understanding of breakthrough developments in specific areas. Offered by Electrical & Computer Engineer. May be repeated within the term for a maximum 9 credits.

**Recommended Prerequisite:** TCOM 535.

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment is limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture

**TCOM 691: Advanced Topics in Telecommunications.** 3 credits.
Advanced topics from recent developments and applications in various engineering disciplines in specialty modules 1, 2, and 3 of TCOM program. Advanced topics chosen so that they do not duplicate existing TCOM courses. Active participation of students encouraged in form of writing and presenting papers in various research areas of advanced topic. Enhances professional engineering community's understanding of breakthrough developments in specific areas. Offered by Electrical & Computer Engineer. May be repeated within the degree for a maximum 9 credits.

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Independent Study

**TCOM 698: Telecommunications Projects Course.** 3 credits.
To be taken toward end of degree program within any of modules 1, 2, or 3. Primary activity is completing major applied project, preferably with group of two to three people. Secondary goal is consolidating training before graduation so that, in some cases, it may act as capstone course. Students and outside telecommunication industry managers present ideas for projects and, through grouping of students, new skills and approaches may be learned. Some class time used for discussion of projects, either to monitor progress or explore alternative approaches. Readings, class-time discussion of current trends, difficulties, and new opportunities for industry most relevant to module. Concludes with presentations of projects to department faculty. Offered by Electrical & Computer Engineer. May not be repeated for credit.

**Recommended Prerequisite:** Graduate standing with at least 18 credits or permission of department.

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture

**TCOM 699: Telecommunications Project Course.** 3 credits.
Capstone of degree program under the specialty modules 4 or 5. To be taken toward end of degree program. Primary activity is completion of major applied project, preferably as two- to three-person group. Secondary goal is consolidation of training before graduation. Students, outside telecommunication industry managers present ideas for projects. From these ideas, group projects selected. Some classroom time used to discuss projects, to either monitor progress or explore alternative approaches. Readings, classtime discussion of current trends,
difficulties, and new opportunities for the industry. Projects presented to department faculty at end of semester. Offered by Electrical & Computer Engineer. May not be repeated for credit.

**Recommended Prerequisite:** Completion of at least 24 credits in the MS in Telecommunications program.

**Registration Restrictions:**
Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture

**700 Level Courses**

**TCOM 707: Advanced Link Design.** 3 credits.
Topics include advanced satellite link design such as VSAT optimization, intersatellite systems, and propagation mitigation trade-offs; radar link design such as primary and secondary radars, range ambiguities, false alarms, Doppler radar, FM radar, radar tracking, radar transmitters and receivers, and phased array radars; terrestrial wireless link design including line of sight, LMDS, and nonlinear of sight; optical link design including laser options, diffraction limits, lidar and communications links, tracking limitations, and GEO and LEO intersatellite link design; Wi-Fi link design; and directed energy systems. Offered by Electrical & Computer Engineer. May not be repeated for credit.

**Recommended Prerequisite:** TCOM 551, TCOM 607, or permission of instructor.

**Registration Restrictions:**
Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may not enroll.

Enrollment limited to students in the College of Science, Schar School of Policy and Gov or Volgenau School of Engineering colleges.

**Schedule Type:** Lecture

**TCOM 750: Coordinating Seminar.** 3 credits.
Open only to students in MA or MS in telecommunications programs with at least 18 credits of course work prior to registration. Topics include specific telecommunications problems in management, law, engineering, education, and communications. Focuses on ways a problem in one area can create or solve a problem in other areas. Offered by Electrical & Computer Engineer. May not be repeated for credit.

**Recommended Prerequisite:** Open only to students in the MA or MS in telecommunications programs with at least 18 credit hours of course work prior to registration.

**Registration Restrictions:**
Enrollment is limited to students with a major in Telecommunications or Telecommunications.

Enrollment is limited to Graduate or Non-Degree level students.