Universidad del Turabo

School of Engineering

2005-2006

Graduate Catalog &
Academic Norms

(Revised September 15, 2005)
Recognizing the need for engineering professionals in Puerto Rico’s accelerating economic environment, the AGMUS Board of Trustees approved in August 1990, the establishment of a School of Engineering at the University of Turabo. The School of Engineering started with an initial enrollment of 75 students in Academic Year (AY) 1990/91 and currently offers associate degrees in technology, baccalaureate programs in Mechanical Engineering, Electrical Engineering, and Industrial and Management Engineering, and a Master of Science in Administration of Telecommunications and Network Systems in day and evening sessions. The School is committed to the success of every student and pursues this goal by offering small classes taught by highly qualified faculty, a wide range of student services, modern facilities and equipment, and opportunities for undergraduates to participate in faculty-directed research, special design projects and industrial internships.

The School of Engineering is housed in the modern Sandia National Laboratories Engineering Building, named in recognition of the support provided by the U.S. Department of Energy. This facility includes classrooms, instructional and research laboratories, offices for faculty and staff, meeting and conference rooms, and a student study room. It was occupied in August 1992. The building was expanded in 1998 to house seven Electrical Engineering laboratories designed for instructional and research use.

The School of Engineering has three academic departments:

Department of Mechanical Engineering
Department of Electrical Engineering
Department of Industrial and Management Engineering

In addition, the School of Engineering has two Institutes focused on associate and advanced technology degrees.
Vision

The vision of the School of Engineering is to become the school of choice for all students interested in a technology or engineering degree, and to be recognized for its excellence in teaching and research.

Mission

The mission of the School of Engineering is:

- To provide our students at all degree levels, associate, bachelor and graduate, with an excellent education that allows them to become competitive at a national level in their chosen field of expertise, and responsive to the needs of their communities.
- To serve the community through scholarly activities at the pre-college and college levels, through research and development, and through programs that serve the needs of industry.

Telecommunications Curriculum

The School of Engineering offers academic programs leading to a Master of Science in Administration of Telecommunications and Network Systems. The program curricula consist of 45 credit hours distributed among seven terms.

Full-time students who follow the recommended course schedules can complete the M.S. in Telecommunications curriculum in two years. Program duration for part-time and transfer students will vary based upon course load and previous course work.

The School of Engineering reserves the right to make changes in course offerings, curricula, and other policies affecting its programs. In the specific case of a curriculum revision, current students will be moved horizontally to the new curriculum. Students will be required to take new courses at a level higher than that at which the student is currently enrolled but never courses at a level below. All current and former students enrolled in the School of Engineering are subject to these conditions.

Graduating Student Profile

Students that complete the M.S. in Telecommunications program at the University of Turabo develop, as a minimum, the following profile:

- An ability to design and implement telecommunications and networking systems
- An ability to design and implement voice and convergence systems
- An ability to design, implement and maintain wireless communication systems
- An ability to administer and participate in strategic management and decision making process as related to telecommunications and networking support systems
- A recognition of the need for, and an ability to engage in life-long learning
- Ability to maintain quality of service in telecommunications and networking systems
• Ability to translate business needs into technical solutions that can support the overall business process
• Ability to create plans for future deployment of technology that could significantly contribute to enhance and solidify the position of the enterprise in the business sector it serves
• Provide guidance, leadership and management of excellence to those under his/her supervision as well as direction in terms of activities and projects both future and current
• Assist management in the preparation of the strategic budget plan in the areas of technology deployment

Application Process and Admission Policy

To be admitted the candidate must fulfill the following requirements:

1. Have a bachelor’s degree on computer sciences, engineering or administration with a concentration in computer sciences from an accredited institution.
2. Approve with no less than 3.00 the courses of Calculus I, Calculus II and Differential equations and in addition a course in analytical programming such as C++ or Pascal and a Basic Statistic course.
3. Must have an academic index of 2.75 overall average in his degree and 3.00 in the major.
4. Submit an official credit transcription with the application.
5. Present evidence of the results of the PAEG or GMAT graduate studies tests or the receipt indicating the date this test will be taken.
6. Three letters of recommendation.
7. Pay the admission quota of $25.00.
8. Approve an interview with the Dean of the School of Engineering and the Director of the Institute of Telecommunications.

Graduation Requirements

To graduate from the Masters degree in Science in Telecommunications and Network Administration the candidate must fulfill the following requirements:

1. Approve all required courses as established by the institution with a minimum Grade Point Average of 3.00.
2. Approve the Thesis dissertation or comprehensive examination and the network implementation project.
3. Transferred students must approve at least 18 credits at Universidad del Turabo. These credits must be in the area of core and specialization requirements.
4. All students admitted to the institution will be subjected to the graduation requirements prevailing in the academic year of their admission.
5. Must have applied in the office of the Registrar for graduation at the establish date published in the academic calendar.
6. No graduation or degree certification document will be granted until evidence of compliance with economic and tuition responsibilities have been submitted.
7. All students requesting readmission will be subjected to the graduation requirements prevailing at the time of their readmission.

Prerequisites

The School of Engineering enforces the prerequisites in its Master of Science in Telecommunications curriculum. Students who register for a course for which they do not have the necessary prerequisites will be dropped from the course before the end of the term receiving a grade of WA.

Repeating Courses

Students may repeat a course in order to improve their Grade Point Average. Credit will be given for the higher grade, which will be used to compute the Grade Point Average. If the grade of the second attempt is the same as the first, they will both be used for cumulative average, but only once for graduation average.

Course required for graduation with grades of D or F must be repeated. A student in the Institute of Telecommunications must complete all courses used to fulfill graduation requirements with a grade of C or better.

Students are permitted two attempts to complete any course used to fulfill graduation requirements with a grade of C or better. Courses for which a student receives a “W”, “WA”, “WR”, or “WN” are not counted as attempts. Courses for which a student receives a “WF” are counted as attempts. In the case of the courses of the Masters degree in Telecommunications and Networks Administration, the student will be able to repeat a course a maximum of two (2) attempts. The student will be able to repeat a course for the second time only with the approval and recommendation of the Director. If the student does not successfully complete the course on the second attempt, the student is suspended from the School of Engineering but may continue in other academic programs at the University of Turabo. Readmission to the School of Engineering is at the discretion of the Dean of the School of Engineering.

Students may not repeat a course until a grade has been given. The Institution will authorize the student who has obtained a grade of C, D, F, WF, WA or WN in a course to repeat such course with financial assistance as long as the maximum of 150% of attempted credits have not been surpassed. Repeated courses will be considered in determining a student’s satisfactory progress.

Withdrawals

See the established university policy.
Academic Advising

Upon acceptance to the School of Engineering, all students will be assigned an academic advisor. Each semester it is required that students meet with their academic advisors during pre-registration to discuss their progress and academic goals. The Director of Engineering Advising and Student Services in the School of Engineering manages advising activities and procedures.
INSTITUTE OF TELECOMMUNICATIONS AND INFORMATION TECHNOLOGY

Rafael M. Rivera, Director

Recognizing the importance of telecommunications in the modern enterprise, the Universidad del Turabo has established a unique organization within the School of Engineering, dedicated solely to the development of graduate, undergraduate and certifications in this important discipline. The Institute of Telecommunications and Information Technology, hereon designated as \(\text{IT}^+\), has established the most advanced laboratory facilities in the Caribbean, dedicated to investigation and the learning and advancement of all disciplines comprised and related to telecommunications.

Vision

The vision of \(\text{IT}^+\) is to become the most advanced center for education and investigation in the telecommunications area in Puerto Rico and therefore become the prime choice of students considering education in this area.

Mission

The mission of the Institute of Telecommunications and Information Technology (IT+) is:

- To provide our students at all degree levels, associate, bachelor, and graduate, with an education of excellence that will allow them to be competitive at a national level in the fields of telecommunications and information technology and responsive to the needs of the communities they serve.

- To serve the business and academic investigation communities through scholarly activities at all levels through research and development activities and programs that serve the needs of these communities, industry and government.

Objectives

The objectives of this graduate program are:

1. To develop a professional in the telecommunications field that will have the necessary skills to effectively perform in the process of designing and implementing telecommunications systems in the modern enterprise.

2. As professionals responsible for the design, implementation and administration of telecommunications and network systems, the program’s goal is to produce a graduate that will conduct him/herself with the highest sense of ethics and responsibility.

3. To develop a professional capable of satisfying the demand in Puerto Rico, Central America, the Caribbean and the United States for individuals capable of directing the multiple and essential changes required by the modern
enterprise in the area of telecommunications and networking systems, thus contributing to the success and advancement of the corporation.

The Faculty of the Institute of Telecommunications, through a set of measurable outcomes, and with the input of students and an Industry Curriculum Advisory Board, systematically measures the effectiveness of the program in satisfying its educational objectives and continuously strives to improve.

**Faculty**

**Jeffrey L. Duffany / Associate Professor**
Ph.D., Computer and Information Engineering, Stevens Institute of Technology

**Rafael M. Rivera / Instructor**
M.B.A., Industrial Management, Inter American University
PhD Information Systems in Progress, San Pablo, CEU Madrid

**Eng. Heriberto Arzuaga, TA**
Electrical Engineering, Politecnical University
MBA, Norwich University
PhD Decision Sciences, in progress
Walden University

**Jintao Xiong / Assistant Professor**
Ph.D., Electrical and Computer Engineering, University of Massachusetts

**Technical Staff**

**Wilma N. Pabón / Telecommunications Laboratories Coordinator**
B.S. Electrical Engineering, MS Telecommunications
Universidad del Turabo
MASTER OF SCIENCE IN ADMINISTRATION OF TELECOMMUNICATIONS AND NETWORK SYSTEMS

Description

The Masters of Science in Telecommunications and Network Administration consists of 45 credits distributed as follows:

1. Core and specialization courses: 34 credits
   The core component includes introductory courses in telecommunications principles, local area networks, wide area networks, TCP/IP and Convergence Networks. Specialization courses expand into telephony and network design of both voice and data. It also includes a strong management component concentrating in project management for information systems professionals and probability and stochastic methods. The graduate must design a complete Convergence Network under QoS parameters and prove its design in a laboratory environment.

2. Elective courses: 8 credits
   The student will take an additional course from the administration electives and another course in telecommunications or information systems.

3. Thesis or Comprehensive examination: 3 credits
   The thesis dissertation will be in a topic of investigation related to the effective implementation of telecommunications systems and its impact in the organization. The Comprehensive examination will cover all topics associated with the design of a Network of Convergence and can only be taken three times. Once a choice, either Thesis or Examination is made the student will not be able to opt for a different alternative and will follow the guidelines accordingly.
Administration of Telecommunications and Network Systems Curriculum

(45 credits; 2.5 years)

Core Courses (18 credits)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>TCOM501</td>
<td>Introduction to Networking</td>
<td>4 credits</td>
</tr>
<tr>
<td>TCOM502</td>
<td>Introduction to Local and Wide Area Networks</td>
<td>4 credits</td>
</tr>
<tr>
<td>TCOM503</td>
<td>Introduction to TCP/IP</td>
<td>4 credits</td>
</tr>
<tr>
<td>IMEN551</td>
<td>Engineering Project Management</td>
<td>4 credits</td>
</tr>
<tr>
<td>TCOM510</td>
<td>Probability and Stochastic Processes for Science and Engineering</td>
<td>3 credits</td>
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</table>

Concentration Courses (16 credits)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCOM507</td>
<td>Convergence of Technologies</td>
<td>4 credits</td>
</tr>
<tr>
<td>TCOM506</td>
<td>IP Telephony</td>
<td>4 credits</td>
</tr>
<tr>
<td>TCOM505</td>
<td>Design and Implementation of Voice Networks</td>
<td>4 credits</td>
</tr>
<tr>
<td>TCOM504</td>
<td>Network Analysis and Design</td>
<td>4 credits</td>
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</tbody>
</table>

Thesis or Comprehensive Exam (3 credits)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>TCOM600</td>
<td>Thesis Advisory</td>
<td>3 credits</td>
</tr>
<tr>
<td>TCOM601</td>
<td>Comprehensive Exam</td>
<td>3 credits</td>
</tr>
</tbody>
</table>

Telecommunications Electives

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSEC501</td>
<td>Network Security I</td>
<td>4 credits</td>
</tr>
<tr>
<td>NSEC502</td>
<td>Computer Security I</td>
<td>4 credits</td>
</tr>
<tr>
<td>NSEC521</td>
<td>Network Security II</td>
<td>4 credits</td>
</tr>
<tr>
<td>NSEC522</td>
<td>Computer Security II</td>
<td>4 credits</td>
</tr>
<tr>
<td>TCOM58</td>
<td>Implementation of Data Networks</td>
<td>4 credits</td>
</tr>
<tr>
<td>TCOM509</td>
<td>Protocol Analysis</td>
<td>4 credits</td>
</tr>
<tr>
<td>TCOM511</td>
<td>Internet Technologies</td>
<td>4 credits</td>
</tr>
<tr>
<td>TCOM512</td>
<td>Internetworking Devices</td>
<td>4 credits</td>
</tr>
<tr>
<td>Semester</td>
<td>Course</td>
<td>Credits</td>
</tr>
<tr>
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</tr>
<tr>
<td><strong>First Semester</strong></td>
<td>Introduction to Networking</td>
<td>3 credits</td>
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<tr>
<td></td>
<td>Probability and Stochastic Processes for Science and Engineering</td>
<td>3 credits</td>
</tr>
<tr>
<td></td>
<td>Introduction to Local and Wide area Networks</td>
<td>4 credits</td>
</tr>
<tr>
<td></td>
<td>Total Credits for 1\textsuperscript{st} Semester</td>
<td>10 credits</td>
</tr>
<tr>
<td><strong>Second Semester</strong></td>
<td>Introduction to TCP/IP</td>
<td>4 credits</td>
</tr>
<tr>
<td></td>
<td>Engineering Project Management</td>
<td>4 credits</td>
</tr>
<tr>
<td></td>
<td>Elective I</td>
<td>4 credits</td>
</tr>
<tr>
<td></td>
<td>Total Credits for 2\textsuperscript{nd} Semester</td>
<td>12 credits</td>
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<tr>
<td><strong>Third Semester</strong></td>
<td>Convergence of Technologies</td>
<td>4 credits</td>
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<tr>
<td></td>
<td>IP Telephony</td>
<td>4 credits</td>
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<tr>
<td></td>
<td>Design and Implementation of Voice Networks</td>
<td>4 credits</td>
</tr>
<tr>
<td></td>
<td>Total Credits for 3\textsuperscript{rd} Semester</td>
<td>12 credits</td>
</tr>
<tr>
<td><strong>Fourth Semester</strong></td>
<td>Network Analysis and Design</td>
<td>4 credits</td>
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<tr>
<td></td>
<td>Elective II</td>
<td>4 credits</td>
</tr>
<tr>
<td></td>
<td>Total Credits for 4\textsuperscript{th} Semester</td>
<td>8 credits</td>
</tr>
<tr>
<td><strong>Fifth Semester</strong></td>
<td>Thesis Advisory or Comprehensive Examination</td>
<td>3 credits</td>
</tr>
<tr>
<td></td>
<td>Total Credits for 5\textsuperscript{th} Semester</td>
<td>3 credits</td>
</tr>
</tbody>
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*Total Program Credits* 45 credits
Course Descriptions

Description of Core and Specialization Courses

TCOM 501
**Introduction to Networking**
Three credit hours

Provides an introductory overview of the fundamental concepts of networking and data communications. This course is designed for those students who have basic experience using a computer, and would like a better understanding of how networks move information between computers. This course brings together the acronyms, protocols and components that are essential to understanding how networks operate today. Students will learn how signals travel across different types of physical network structures, and how those signals carry useful data from one device to another. The same key principles and components form the foundation of all networks, from the smallest peer-to-peer systems to the worldwide Internet. The knowledge gained in this course will serve as a firm foundation for a continued course of study in networking.

*Prerequisites: Admission to the program*

TCOM 502
**Introduction to Local and Wide Area Networks**
Four credit hours

Explains the concepts, technologies, components, and protocols used in local area networking (LAN) environments. Students will learn about the popular LAN protocols of Ethernet, Token Ring, and asynchronous transfer mode (ATM), with emphasis on all speeds of Ethernet. This course also introduces the most widely used network operating systems: Novell NetWare, Windows NT, and Windows 2000. Participants will see how computers work together in both peer-to-peer and client/server networks. They will also learn the first principles of network design, as they learn how to use hubs, bridges, switches, and routers to optimize network traffic.

Gives a solid understanding of the fundamental concepts of LAN operation. This knowledge provides a clear advantage when taking other courses to learn how to administer specific network operating systems. The Wide Area Network component of this course begins with a discussion of fundamental concepts related to WAN technologies and services. The network used to provide many of the WAN data services today was originally developed to carry voice-grade traffic only. The old analog network has been updated to a primarily digital network; however, analog local loops still connect home and many business users to the digital telephone network.

*Prerequisites: TCOM 501*
TCOM 503
**Introduction to TCP/IP**
Four credit hours

The world's largest network, the Internet, is also one of the world's most powerful communication tools. This course will cover the underlying applications, components and protocols of TCP/IP and its necessary link to the Internet. The Introduction to TCP/IP course will help participants learn how to identify TCP/IP layers, components and functions. Navigation tools, TCP/IP services and troubleshooting methodologies are also covered in this course.

The Internet Technologies component of this course begins with an overview of the Internet, its history, organization and structure. Once the general structure is understood, we look at different ways to access the Internet, both as an individual user and as a group of users. Web clients and servers and the underlying protocols used by both are also covered as well as the requirements for building a web server. The final portion of the course reviews the many applications that are used for retrieving information or providing information across this global network of networks.

*Prerequisites: TCOM 501*

TCOM 504
**Network Analysis and Design**
Four credit hours

This is an advanced course intended for networking professionals and students who already grasp the general concepts of data communications and networking, but would like a more detailed understanding of network design and analysis. This course will present methods for analyzing, designing and managing computer networks.

Sample Outcomes:
- Understand the network life cycle as it relates to design and analysis
- Understand key end user requirements used in network design
- Understand the impacts of various applications to operation of networks
- Understand performance characteristics of computer networks
- Evaluate data flow through a network
- Understand how to design networks logically
- Understand how to translate logical designs into physical designs
- Develop addressing strategies for a network

*Prerequisites: TCOM 503*

TCOM 505
**Design and Implementation of Voice Networks**
Four credit hours

This course explains the structure and design of telecommunication networks, both large
and small. It begins with an overview of the public telephone network, and describes the large networks and transmission facilities that switch telephone calls. The focus then narrows to the PBX switching systems that are essential to most businesses. You’ll receive a thorough explanation of the components and functions of a typical PBX, with special emphasis on the architecture of the Lucent DEFINITY.

After introducing the public telephone network, the course introduces the digital transmission services that operate over that network. You’ll be able to explain the operation, protocols, strengths, and weaknesses of point-to-point services, such as T1, and switched services, such as Frame Relay and ATM.

To explain the critical interface between the customer premises and the public network, the course concludes by introducing the science of traffic engineering. It introduces the three most common methods of estimating the optimum trunk capacity of a phone system, and offers practical advice for gathering the raw data necessary for traffic engineering calculations.

Co-requisites: TCOM 506

TCOM 506
IP Telephony
4 credit hours

Presents and explains the many and varied techniques, solutions, principles, and challenges both carriers and end users utilize, experience, and overcome in implementing voice over IP services. This course explores the various protocols involved, the QOS challenges we face and ways we can overcome them, engineering principles to consider when designing a VoIP solution, market drivers and applications, security issues, and carrier options.

More and more today, businesses want to consolidate different types of communication traffic, such as voice calls, data transmission, and video conferencing, onto a single network infrastructure. This can simplify the communications process (fewer lines and network providers to manage) and cut call costs.

IP Telephony is helping to make this possible, by allowing standard public-network calls to be carried over packet networks such as the Internet. Through IP Telephony, businesses can save significantly on both voice calls and fax services. Newer software now allows remote and traveling workers to take advantage of IP Telephony from either desktop or laptop computers.

Prerequisites: TCOM 505

TCOM 507
Convergence of Technologies
4 credit hours
Technology convergence is the trend toward creating single networks that support many different types of traffic: data, audio, video, and interactive multimedia. This course explains the functional requirements of a converged network, and shows how various technologies make convergence possible by providing each of those functions. The course first focuses on the critical need for increased bandwidth, by reviewing the standard LAN and WAN protocols used in the most common networking configurations. It then introduces several emerging protocols and technologies that promise to provide the quality of service necessary for the transmission of time-sensitive information. With this foundation in place, the remainder of the course concentrates on practical applications of convergence. You will see how large call centers use close integration of data and voice networks to efficiently deliver high levels of customer service.

*Prerequisites: TCOM 502*

**TCOM 508**  
**Implementation of Data Networks**  
4 credit hours

Explains the process of designing and implementing a new network or network upgrade. It covers this complex process in a step-by-step way so as to break this complex job into four major phases, each with its own inputs, tasks, and outputs: Concept, Development, Implementation and Termination. This process mirrors the engineering phased approach to design disciplines. This is because a network, like a bridge, application, or house, is a unique solution to a particular set of needs. The details of installation and maintenance depend heavily on each network’s specific architecture and physical topology. This course introduces each of these phases, but concentrates on the implementation phase.

*Prerequisites: TCOM 504*

**IMEN 551**  
**Engineering Project Management**  
3 credit hours

Practical aspects of project scheduling and resource management in areas such as software development, start-ups or shut down of operations. A project will be required for students to apply concepts and software available in laboratory.

*Prerequisites: Admission to the program*
Telecommunication Electives

TCOM 509
Protocol Analysis
4 credit hours

This is an advanced course intended for networking professionals and students who already grasp the general concepts of data communications and networking, but would like a more detailed understanding of the processes and protocols used in today’s networks. Network architectures will be discussed from an OSI model perspective of the networking protocol stack, and a detailed analysis of the protocol will ensue using traces taken with protocol analyzers.

Prerequisites: TCOM 507

TCOM 511
Internet Technologies
4 credit hours

The course begins with an overview of the Internet, its history, organization and structure. Once the general structure is understood, we look at different ways to access the Internet, both as an individual user and as a group of users. Areas such as copyrights issues, bandwidth considerations, portal development, practical research using the internet, FTP and electronic mail, XHTML, web servers, graphics, scripts, tables, audio, video and security are covered.

Prerequisites: TCOM 501

TCOM 512
Internetworking Devices
4 credit hours

Advanced course intended for networking professionals and other participants who grasp the general concepts of data communications and networking, but would like a more detailed understanding of internetworking and internetworking devices. The course focuses on the issues that are encountered with network growth and the internetworking components that offer solutions to these problems. The components covered in this class include repeaters, hubs, bridges, switches, routers and gateways. Network Management and the Simple Network Management Protocol (SNMP) are also discussed.

Prerequisites: TCOM 511

NSEC501
Network Security I
4 credit hours

Prerequisites Admission to the Graduate Program

NSEC502
Computer Security I
4 credit hours

Topics to be covered include: concept of domains and domain controllers, trust relationships, users and password administration, the active directory, Access Control Lists (ACLs), security audits, data backup and restoral, file encryption, shared drives and folders, Microsoft Exchange security, Kerberos, Radius servers, Remote Access Service, system event log, Network Monitor and Trusted Solaris

Prerequisites Admission to the Graduate Program

NSEC521
Network Security II
4 credit hours

Overview of Local and Wide Area networks. Introduction to both wired and wireless networking equipment. Configuration and administration of internetworking devices from a network security point of view.

Prerequisites: NSEC501

NSEC522
Computer Security II
4 credit hours


Prerequisites: NSEC502