

## **A Model of Undergraduate Computer Networking Education**

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### Abstract

The computer networking education offered by the Indiana University-Purdue University Fort Wayne (IPFW) will prepare students for hardware/software jobs related to computer networking, network system administration, and Internet-based information systems. It includes courses in computer operating system basics (DOS, UNIX, Windows and Windows NT), C programming language and applications, data communications, local area networks and network systems administration (UNIX and Window NT server), wide area network design, and topics in computer networking including experimental, applied, and/or practical projects. In this paper, we discuss an A.S. degree in computer engineering technology (computer networking concentration), program rationale, certificate program, and networking courses.

### I. Introduction

Over the last two decades, electrical and electronics engineering technology departments around the United States have increasingly been faced with the problems of trying to keep up with rapid advances in computer technology, which requires more technical courses and material in the already overburdened curricula. The Electrical Engineering Technology (EET) Department at Indiana University-Purdue University Fort Wayne (IPFW) was changed to the Electrical and Computer Engineering Technology (ECET) in the fall of 1996. The ECET department attempted to enhance courses related to modern computer engineering technology and yet continue to emphasize the traditional EET program. In recent years, the ECET department developed many new courses including CPET 181 Computer Operating Systems Basics, CPET 281 Local Area Networks, CPET 284 Networking Security, CPET 384 Wide Area Networks Design, EET 382 C++ Object-Oriented Programming Language with Industrial Applications, EET 355 Introduction to Data Communications, EET 466 Windows Programming for Industrial Applications, and CPET 499 Java Computing and Networking for Industrial Applications.

In attempting to redesign our curricula in order to satisfy the demand from students, employers, and the advance of technology, we have developed a specialized A.S. degree program called Computer Engineering Technology (computer networking concentration) as well as a certificate program in Computer Networking.

The CPET A.S. degree program is intended to serve lower-division undergraduate students who may attend school on either a full-time or part-time basis with employed adults being the majority. For most of these students, the associate degree will serve as a milestone on the way to a four-year degree. All courses will be offered in the evening to meet these needs. Most of the specialization courses will only be offered in the evening or use distance-learning methods (TV, Internet, etc). It includes courses in computer operating system basics (DOS, UNIX, Windows and Windows NT), C programming language and applications, data communications, local area networks and network systems administration (UNIX and Window NT server), wide area network design, and topics in computer networking including experimental, applied, and/or practical projects.

The proposed A.S. degree program described below was approved by the School of Engineering, Technology, and Computer Science, IPFW and is still in the approval process. The ECET department started to offer courses in the spring of 1998 and a certificate program in Computer Networking has been approved.

## II. The A.S. Computer Engineering Technology Program

The Associate of Science in Computer Engineering Technology degree will provide a superior technical education in an area of specialization. These areas will follow the rapidly evolving, intertwined areas of computer and electronic technology and may include telecommunications, local area networking, wide area networking, and use of the Internet for communications and control. The initial specialization proposed is local area networking. The program is intended to provide:

- a. a degree to students interested in emerging areas of computer engineering technology,
- b. students with the computer and electronics background necessary to operate, maintain, and manage devices and systems that are computer controlled or supervised by computer communications,
- c. a degree for nontraditional students who desire to increase their knowledge as technicians, operators, or managers in emerging areas of computers and electronics,
- d. an initial technical degree that is employable and will also enable graduates access to a Bachelor of Science in Electrical Engineering Technology, Computer Science, or Information Systems with some additional coursework.

Upon completion of the associate degree, students will have the following commensurate with a technical associate degree:

- a. knowledge of mathematical reasoning,
- b. knowledge of effective written and oral communication,
- c. ability to operate computer controlled devices,
- d. ability to maintain and manage computer and electronic devices and systems,
- e. ability to program computer controlled devices.

Student Demand: Enrollment projections were based on experience with existing technical Associate of Science programs, discussions with students, discussions with members of the Industrial Advisory Committee of the department of Electrical and Computer Engineering Technology, and a survey of local businesses. The curriculum is

expected to add to the total enrollment of the campus because the program will address current technical needs of the community involving emerging computer technologies. Some projections are shown in Table 1.

Table 1: Program Enrollments and Completions

	Annual Totals by Fiscal Year		
	Year 1	Year 2	Year 3
	<u>1999-00</u>	<u>2000-2001</u>	<u>2001-2002</u>
A. Program Credit Hours Generated			
1. Existing Courses	45	180	290
2. New Courses	<u>30</u>	<u>150</u>	<u>190</u>
TOTAL	75	330	480
B. Program Majors (Headcounts)			
1. Full-time Students	3	6	9
2. Part-time Students	<u>8</u>	<u>14</u>	<u>21</u>
TOTAL	11	20	30

Transferability: Fourteen courses in this AS CPET degree can be credited toward the AS in EET and four more can count toward the BS in EET. In addition, at least ten courses in the AS CPET degree can count toward the BS Information Systems or Computer Science degrees.

Demand and Employment Factors: Employment possibilities in the areas of computers and electronics such as telecommunications, local computer networking, use of the Internet for communications and control, and other emerging technical areas are growing with the technology. The graduate will have the technical and computer skills for ready employment. Most graduates will seek or continue employment in Northeast Indiana or continue for the BS degree. An extract from the Indiana Department of Workforce Development State and Local Labor Market Information (OSE Industry-Occupation Matrix, date 1/20/98) is shown in Table 2.

Table 2. Distribution by Occupation, 1994 and Projected 2005

Area: INDIANA STATEWIDE				
	Base Year 1994	Projected Year 2005		
<u>Occupation Title</u>	<u>Employment</u>	<u>Employment</u>	<u>Change in Employment</u>	<u>% Change</u>
Electrical & Electronics				
Engineers	4809	5615	806	16.76
Computer Engineers	1388	2648	1260	90.78
Electrical & Electronic Technicians	5528	6167	639	11.56
Computer Support Specialists	647	1172	525	81.14
All Other Computer Scientists	1477	2946	1469	99.46

The categories in the table shown contain the jobs for which the majority of graduates of this CPET degree including those that choose to continue for their BS will compete.

Some of the jobs within each of the categories in the table are listed below to show more specific job titles that fall within the occupation titles:

Computer Engineers: Computer Systems Hardware Analyst

Computer Support Specialists: User Support Analyst Supervisor, User Support Analyst, Microcomputer Support Specialist

All Other Computer Scientists: Supervisor of Network Control Operators, Data Communications Analyst, Network Control Operator, Technical Support Specialist

Other jobs for which graduates will compete are in the fields of industrial control networking, programmable logic controller networking, network administration, network servicing, network upgrading.

### III. Description of the Curriculum

The curriculum described in Table 3 below provides a technical education in the area of computer networking. The core courses provide the student with basic instruction in analog and digital circuit analysis with hands-on laboratory work required. It also introduces the fundamentals of computer use, programming, and application using word processors, spreadsheets, and high and low level computer languages. The specialization courses provide more in-depth knowledge about computer networking and the requisite hardware and software. The other required courses are needed in order for the students to have sufficient mathematical and communication skills, and knowledge of the industrial environment to contribute effectively in the workplace.

Table 3. The A.S. Degree Credit Hour Distribution

Core: 26 credit hours

3	EET/CS 114	Intro to Microcomputers
4	EET 111	Digital Circuits
4	CPET 101	Electrical Circuits
4	CS 160	Intro to Computer Science I
4	CS 161	Intro to Computer Science II
3	EET 264	Programming Language Applications
	OR CS 170 C and Data Structures	
4	EET 205	Intro to Microprocessors

Options or specialization: 16 credit hours

3	CPET 181	Computer Operating Systems Basics
3	CPET 281	Local Area Networks
3	CPET 284	Networking Security
4	CPET 355	Intro to Data Communication
	OR CS 274 Data Communications (plus 1 hour of lab)	
3	CPET 384	Wide Area Network Design
	OR CS 374 Computer Networks	

Other Required: 18 credit hours

Mathematics		
3	MA 153	Algebra and Trigonometry I
3	MA 154	Algebra and Trigonometry II
Oral and written communication		
3	ENGW131	Elementary Composition I

3	ENG W234	Technical Report Writing
3	COM 114	Fundamentals of Speech Comm.
General industrial education		
3	IET 105	Industrial Organization
	OR Bus W100	Business Administration
Elective: 3 credit hours		
<u>3</u>	Technical Elective	
63	Total	

#### IV. The Computer Networking Certificate

The major objective of this certificate is to address leading issues in computer networking technologies and to provide practical knowledge of analysis, design, and implementation of local area network systems and subsystems (both on hardware and software). The certificate program features such courses as Windows operating systems and UNIX, programming in C, local area networks, data communication components and protocols, networking security, and wide area networking. These courses were designed to be taken in the sequence as shown in Figure 1.

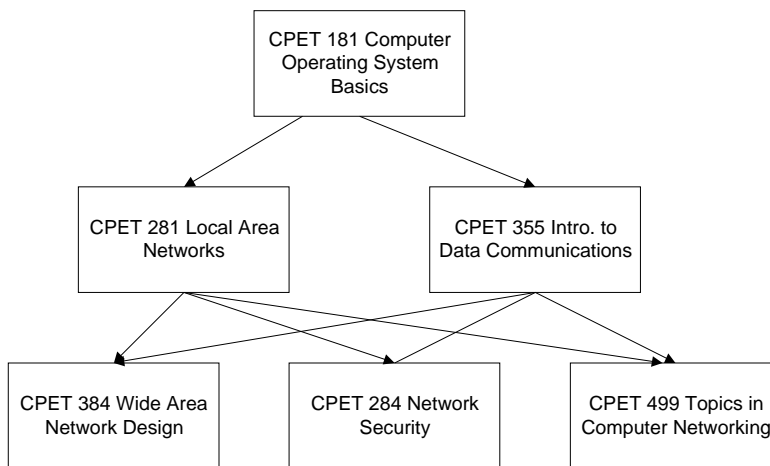


Figure 1. A typical building block structure of the CPET courses

The certificate will be awarded upon satisfactory completion of the following courses.

3	CPET 181	Computer Operating Systems Basics
3	EET 264	C Programming Language Applications
		or CS 170 C and Data Structures or equivalent
3	CPET 281	Local Area Networks
4	CPET 355	Introduction to Data Communications
		or CS 274 Data Communications plus 1 hour lab
3	CPET 284	Network Security
3	CPET 384	Wide Area Network Design
		or CS 374 Computer Networks
		or CPET 499 Topics in Computer Networking

19 Total

## V. The First Year Experience

CPET 181 was offered for the first time in the spring of 1998. It covered the following operating systems: MS-DOS, Windows 95/98/NT, and UNIX (Linux and Solaris). The course web site (<http://etcs.ipfw.edu/~lin>) shown in Figure 2 was designed to enhanced student learning.

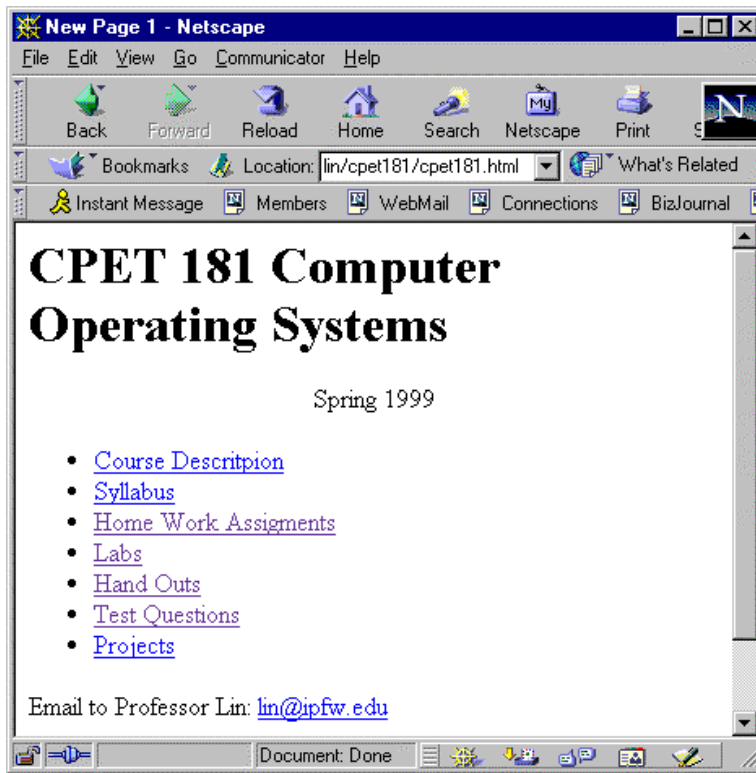


Fig. 2. The Web Site for CPET 181 Computer Operating Systems Basics

Of the other new courses, CPET 281 was first offered in Fall 99, CPET 384 will be offered for the first time in Spring 2000 using a team teaching approach, and CPET 284 will be offered for the first time in Fall 2000.

## VI. Summary

The availability of modern computing resources makes the update of the electrical and computer engineering technology program not only possible, but also necessary, in order for EET and ECET departments to remain competitive and meet modern needs. The A.S. degree program in Computer Engineering Technology (computer networking concentration), computer networking certificate program, and networking courses are designed to prepare the ECET department for technological challenges. Although these five networking specialization courses were originally designed for the A.S. degree program, they are also used in the computer networking certificate program. The need to

add real world computer and networking technologies to electrical and computer engineering technology programs will continue to grow in the future.

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Lin is Associate Professor and Chair of Electrical and Computer Technology Department of Indiana University - Purdue University Fort Wayne. He has been with Purdue University since 1985. He is a registered Professional Engineer in Electrical Engineering at State of California and at the State of Indiana. Previously, he taught at Engineering and Technology Department of Dutchess Community College (NY) for three years (from 1982-1985), at Electrical Engineering Department of National Taipei Institute of Technology for two years, and worked in industry for 8 years. Lin is a Senior member of IEEE and was the Chairman of the Manufacturing Systems Development and Application Department of IEEE-Industry Applications Society from January 1998 to December 1999. Lin's current interests include distributed intelligent control of embedded real-time system, and sensors in industrial control applications.

#### HAL BROBERG

Hal taught Electrical Engineering for 3 years at the U.S. naval Academy and after retirement from the Marine Corps as a Lieutenant Colonel, chose to continue teaching. He received his PE license in Indiana in 1988 and his PhD in Engineering (EE) in 1993. His research area is servo systems and he has consulted and worked for ITT (Aerospace-Communications) on weather satellite servos for the past 8 years. He is currently an Associate Professor in the ECET department at Indiana Purdue University in Fort Wayne, IN, a senior member of IEEE and a program evaluator for IEEE with ten TAC/ABET accreditation visits completed.