Internet/Web Services

Networking Services

User Support Services

Guidelines
for
Associate Degree Programs to Support Computing in a Networked Environment

Association for Computing Machinery
The First Society in Computing

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To All Computing Educators:

For several decades, ACM has been a leader in formulating curricula guidelines for computing-related fields at all levels from high school through graduate school. From 1990-1993, the Two-Year College Education Committee, a standing committee of the ACM Education Board, coordinated the creation of a comprehensive set of computing curricular guidelines for two-year colleges. These guidelines were published in 1993 as a four-volume set by ACM Press. In addition to "Computing Sciences", "Computing for Information Processing", "Computing and Engineering Technology", and "Computing for Other Disciplines", the curricular areas included a newly-emerging area that the Committee called "Computer Support Services" (CSS). The goals of the CSS report were defined to prepare graduates at the associate-degree level for work in three types of activities: networking setup and support, hardware support, and applications support. Since 1993, this CSS area has changed so dramatically that the original guidelines are very much out of date.

In March 1998 the Committee received funding from the ACM Education and SIG Boards to update the CSS guidelines. To this end, the Committee formed a Task Force of fourteen computing professionals consisting primarily of faculty at two-year colleges. The Committee and Task Force members formulated a draft set of guidelines in June 1998. These guidelines have gone through several iterations of review and revision since that time. The quality of the current guidelines is a result of many volunteer hours from the Committee members, Task Force members, and academic and industry reviewers.

The Committee, through Pikes Peak Community College, was recently awarded an NSF Advanced Technological Education (ATE) grant. This ATE project will develop, test, and validate a national model for the adaptation and implementation of an advanced technology curriculum by using the current technologies of satellite teleconferencing and varied Internet resources. The primary goal of the project is to provide guidance to two-year college faculty and administrators in developing one-year certificate and two-year degree programs designed to prepare graduates for computing in a networked environment. More information on this and other Committee projects can be found on the Two-Year College Education Committee Web site <http://www.acm.org/education/>.

The ACM Two-Year College Education Committee
May 1, 2000

GUIDELINES
FOR
ASSOCIATE-DEGREE PROGRAMS
TO SUPPORT COMPUTING
IN A NETWORKED ENVIRONMENT

Produced By The
ACM Two-Year College Education Committee

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GUIDELINES FOR ASSOCIATE-DEGREE PROGRAMS
TO SUPPORT COMPUTING IN A NETWORKED ENVIRONMENT

EXECUTIVE SUMMARY

For more than a decade, the ACM Two-Year College Education Committee has acquired grants and produced reports to enhance the educational programs at two-year colleges. The impetus for the current report is industry's need for qualified information technology (IT) personnel. Under the direction of the Committee, two-year college and industry representatives have created this report over the two-year period 1998-1999.

This report provides guidance to two-year colleges for preparing graduates to perform competently in careers that support computing in a networked environment. To this end, the Committee has identified content areas and their associated topics and has detailed performance objectives for those topics. While it has not listed courses and semester-by-semester plans of study, the report does provide guidance to implement associate-degree programs to meet the needs of local communities. These guidelines consist of the following four parts:

- Part I, *Program Considerations*, discusses general issues including the relevance and beneficiaries of implementations of the guidelines, qualifications expected of graduates, representative job titles, necessary resources for implementations, articulation, industry certification, keeping a program current, and auxiliary skills such as those provided by general education and other discipline-specific courses.

- Part II, *Program Topics and Objectives*, identifies the scope of the guidelines and provides an extensive collection of content areas, topics, and performance objectives. Each objective contains a specific verb (e.g., identify, evaluate, and analyze) that identifies the expected depth of coverage.

- Part III, *Sample Specialty Programs*, groups the performance objectives to encompass the technical skills and knowledge required for associate-degree programs in each of three areas: User Support Services, Networking Services, and Internet/Web Services. General education requirements are recognized as an important part of these degree programs.

- Part IV, *Supporting Information*, contains a listing of the Task Force members, advisors and reviewers, acknowledgements, and references.

The ACM web site (www.acm.org/education) will contain links to ongoing work by the Committee. The posted information will include specific program implementations by two-year colleges and resource materials for institutions planning to deliver one or more of the suggested programs.

Part I
PROGRAM CONSIDERATIONS

1. Goals and Purposes

This report will provide guidance to colleges in developing associate-degree programs designed to prepare graduates for jobs and careers in positions supporting computing in a networked environment. These guidelines will assist colleges in producing information technology (IT) workers who are productive, competent, able to work independently, and who can manage time effectively in entry-level positions that span a wide range of computing environments requiring support personnel. A sampling of job titles for graduates is identified in the following list:

Computer Operator	Lab Computing Coordinator	Software Support Specialist
Computer Repair Technician	Microcomputer Support Specialist	Software Tester
Computer Sales Person	Microcomputer Technician	Software Trainer
Computer Technician	Network Technician	Systems Administrator
Customer Service Representative	Network Administrator	Technical Support Specialist
Desktop Support Technician	Network Analyst	Technology Training Coordinator
Enterprise Network Manager	Network Cabling Specialist	User Support Specialist
Hardware/Software Installer	Network Installer	WAN/LAN Manager
Help Desk Specialist	Network Support Specialist	Web Architect
Help Desk Supervisor	Network Troubleshooter	Web Manager
Help Desk Technician	Office Systems Support Specialist	Web Page Designer
Internet Manager	Operating System Support Specialist	Web Site Developer
Internet Support Specialist	PC Technician	Web Technician

2. Organization of the Report

This report is organized in the following four parts:

- Part I, *Program Considerations*, discusses general issues including the relevance and beneficiaries of implementations of the guidelines, qualifications expected of graduates, representative job titles, necessary resources for implementations, articulation, industry certification, keeping a program current, and auxiliary skills such as those provided by general education and other discipline-specific courses.

- Part II, *Program Topics and Objectives*, identifies the scope of the knowledge base for programs to support computing in a networked environment and provides an extensive collection of content areas, topics, and performance objectives. Each objective contains a specific verb (e.g., identify, evaluate, and analyze) that identifies the expected depth of coverage.

- Part III, *Sample Specialty Programs*, groups the performance objectives to encompass the technical skills and knowledge required for associate-degree programs in each of three areas: User Support Services, Networking Services, and Internet/Web Services. General education requirements are recognized as an important part of these degree programs.

- Part IV*, Supporting Information*, contains a listing of the Task Force members, advisors and reviewers, acknowledgements, and references.

3. Background

These guidelines for programs that support careers in computing in a networked environment are the result of an extensive effort by representatives from two-year colleges and industry. The ACM Education and SIG Boards jointly funded the development of these guidelines that were developed under the direction of the Education Board Two-Year College Education Committee. The Committee has the following goals in presenting this report:

- Encourage and support the implementation of curricula based on these guidelines,
- Use current technologies to disseminate these guidelines,
- Foster communication among professionals in the field,
- Identify and share instructional methodologies, curriculum materials, and computing resources, and
- Provide for continual updating and revision of these guidelines.

Developing curriculum guidelines is an ongoing process for ACM. For example, in 1993 the ACM Two-Year College Education Committee published a comprehensive set of curriculum guidelines that was the result of a multi-year effort involving two-year college and industry personnel. These previous guidelines addressed five areas: Computing Sciences, Computing for Information Processing, Computer Support Services, Computing and Engineering Technology, and Computing for Other Disciplines.

The Committee has recognized the critical need for a major revision to the Computer Support Services guidelines necessitated by advances in computing technologies and the pervasiveness of IT across all organizations. This included significant changes in IT-related job titles, duties, responsibilities, and the demand for qualified graduates with expertise in computing in a networked environment.   In 1998 the Committee organized a task force of two-year college personnel and industry representatives. The task force helped to identify current information technology job titles, specify the associated knowledge base, develop the learning objectives, and organize these objectives into guidelines. The current report is the result of the efforts of the task force, feedback from a set of external reviewers, and ongoing work by the Committee.

4. Relevance

The demand for IT workers and the need for IT worker preparation and continuous retraining are critical national issues. A severe mismatch between the demands of the market for IT professionals and the supply systems of education is a problem that two-year colleges can effectively address. Computing educators face the enormous task of updating their existing programs and defining new programs. This report facilitates the process and supports computing educators in their efforts to acquire the resources necessary to meet this challenge.

5. Beneficiaries

Students, two-year colleges, and employers will benefit from the implementation of the guidelines included in this report. Students will benefit by studying current concepts, methodologies, and practices that have immediate application to the workplace. The education and skills training students will obtain in programs that implement these guidelines will qualify them for fulfilling jobs in the kind of positions cited in Section 1.

Two-year colleges will benefit because they will meet specific needs of both students and industry. Programs implemented by two-year colleges will also attract additional students seeking job enhancement or relevant education for employment. Employers will benefit by being able to hire highly qualified, technically competent personnel in areas of high demand. Because these employees will need little or no in-house training or retraining, employers will experience savings in cost and time. Employees will be able to be productive on the job much more quickly than new hires who might need additional training.

6. Qualifications of Graduates

These guidelines will assist two-year colleges in preparing IT workers who are productive, competent, able to work independently, and who can manage time effectively in entry-level positions that span a wide range of computing environments requiring support personnel. As indicated in Section 1, these positions range from providing technical support at a help desk to administering a network. The support service environments include desktop systems, multimedia technology services, applications software, networking, the Internet and intranets, and the World Wide Web.

Effective support personnel will have a fundamental knowledge of concepts, techniques, and practices in many of these environments with a more comprehensive knowledge and capability in at least one of them. Because colleges can implement a number of different programs from these guidelines, it is not possible to identify a single set of skills to characterize all graduates. However, these guidelines identify a foundation for all students with additional topics and performance objectives for specialty areas. Persons with various backgrounds could complete a one-year certificate program for job enhancement or a change in jobs. Graduates of associate-degree programs will have sufficient educational background to pursue further degrees at various colleges and universities. These graduates will also have requisite skills training to acquire and maintain fulfilling jobs while continuing their education. On the job, employers may expect graduates to work without close supervision (either alone or as a team member); be responsible for tangible and intangible assets; represent the firm to suppliers and customers; have access to certain secure information; locate, analyze, and interpret data; and deal with product problems that arise in the modern workplace.

All associate-degree graduates will have the capacity to assist an end user in a direct (face-to-face) and indirect (through use of technology) manner. They will know the computer systems that they support and the technology for interacting with an end user. Graduates will be able to perform installation, configuration, maintenance, troubleshooting, and documentation services in selected environments; assist in training end users; evaluate and recommend software and hardware; implement extensions to applications programs; and create and maintain a multi-functional Web-based environment. Importantly, the graduates will also be equipped to adapt to changes in computer technology.

7. Scope

These guidelines for computing in a networked environment identify some specialties leading to employment opportunities for computing professionals capable of supporting the computing facility and functioning within an organization, and of assisting users with their computer skills. Part II of this report contains a large collection of content areas, topics, and performance objectives. Each two-year college can select sets of topics and performance objectives based on the potential job market within the local community. The sets can then be assembled into groupings that will define courses within a curriculum.

Part III of the report identifies the content areas, topics, and performance objectives for three sample specialty programs for computing in a networked environment. Implementations at two-year colleges should be based upon the local needs of their communities and may differ from any of these three samples. The wide range of job titles listed in Section 1 suggests both the scope of the guidelines and that many degree implementations are possible. The title of the curriculum will depend on the choices made by the two-year college. For that reason, these guidelines suggest only a sampling of specific curriculum titles.

In addition to selecting the appropriate computing context, required auxiliary skills, and a number of other issues need consideration before establishing a specific curriculum. Incorporation of the skills and decisions concerning the issues will measurably affect the success of the curriculum and the qualifications for employment of its graduates.

Resources

Qualified faculty, access to a sufficient collection of current hardware and software resources, an adequate number of skilled technical support staff, and appropriate instructional materials form the foundation of strong academic programs. Students can only acquire and maintain these resources if there is a source of recurring funding on which to depend for the required ongoing financial support.

- A quality faculty is established and maintained through a series of actions. These include salary scales for full-time and adjunct instructors that are competitive with industry, comprehensive and well-funded staff development programs, support for travel and participation in professional organizations, opportunities for interaction with business and industry, and the provision of the associated instructional support system. At a time when with a significant shortage of skilled computer personnel confronts business and industry, finding and keeping qualified faculty is difficult. Keeping the pay rate for faculty in line with the market rate should lower turnover and encourage more qualified individuals to apply. If a pay scale inequity exists, qualified faculty will soon discover that opportunities for freelance teaching provide them with a considerably higher income. Ongoing training for faculty and technical staff is essential for a program of this type to remain current. Faculty and support staff must be knowledgeable about emerging technologies. A program of continuous professional growth and development is critical to ensure the instructional programs produce graduates that meet industry standards. Such staff training frequently requires travel to seminars, workshops and conferences, and additional coursework. In addition, model staff development programs often include opportunities for faculty to work directly in industry for a specified period of time, participate in vendor-specific certification training, and obtain release time for follow-up activities and curriculum development. Some institutions offer regular sabbatical opportunities for faculty as well.

Each content area defined in this report requires a supply of specialized computer technology, including hardware and software. Colleges must provide student labs to support the degree programs in the realm of computing in a networked environment. In the network-related content areas, students must be able to configure an isolated network without harming the institution's critical systems; this requires networking equipment for use solely by these students. Students in internetworking content areas require technological resources that are highly specialized and often very expensive. Students in user support-related content areas need access to a wide variety of computer hardware and software. Beyond the lab setting, colleges must provide faculty and support staff with equipment that is on a par with the discipline

being instructed. In all cases, colleges must maintain these resources and constantly upgrade them to keep pace with business and industry.

- It is imperative that an institution plan for adequate staffing of lab facilities and the maintenance of computer hardware and software. Once an institution has invested in the faculty and technology required for these programs, it would be an error to shortchange the requirements for support staff. A qualified and adequate staff is needed to provide the technical, clerical, and facility management functions. Issues such as salary, professional development, and equipment support apply to these personnel as well.

- Programs such as these require a collection of technology-based instructional materials designed specifically for teaching and learning activities. Such equipment includes state-of-the-art computer systems classroom/lab instructor stations, projection systems, large-screen monitors, electronic white boards, document cameras, web servers, classroom station-monitoring systems, videotape systems, and other teaching tools.

8. Articulation, Transfer, and Life-Long Learning

Two-year colleges offer a wide variety of associate-level degrees. Typically these degree programs fall into two categories: those designed for transfer into baccalaureate-degree programs and those designed to prepare graduates for immediate entry into career paths. Transfer-oriented associate-degree programs rely on articulation agreements between two-year colleges and four-year colleges and universities to ensure students have a seamless transition between lower division and upper division coursework. Career-oriented associate-degree programs rely on local advisory committees to two-year colleges to ensure students are well prepared with the skills necessary to enter the local workforce. The degree programs described herein are not specifically intended to articulate with baccalaureate-level models. However, many colleges and universities have been creative and aggressive in identifying a variety of articulation agreements to serve graduates of their associate-degree programs.

Students who complete a program defined by these guidelines may choose to obtain immediate full-time employment, continue their studies in another program or institution, or combine work with part-time study. Whether the courses taken are transferable to programs in other institutions depends on what institution and what program the student chooses to follow in future learning. Not all four-year educational institutions will evaluate courses in a particular implementation of these guidelines as being equivalent to their courses. However, many four-year institutions can be approached to consider special articulation agreements to allow students in these programs to count the work toward a higher degree. Many four-year institutions will also give some credit, often under a program for experiential learning, for the accumulated work experience. Many institutions will also give credit under the equivalency programs of the American Council for Education in cases where the program or training has been evaluated and credit has been recommended.

There are many different types of programs in the computing and information technology field, each with different goals and purposes. After working for a time in the field, students will be more aware of the differences and be better prepared to decide on the next phase of their career path. Often students will complete a program and work full-time for several years, and then return to full-time study to work toward career advancement. More commonly, however, students return to study part-time while working full-time. Many companies will provide tuition reimbursement for the workers who wish to continue toward a baccalaureate degree.

9. Certificate Programs

The Committee encourages colleges to offer certificate programs wherever possible. The design of such programs is possible by carefully selecting an appropriate subset of the suggested topics from an associate-degree program. Certificates in computing are becoming a valued asset for individuals seeking employment or advancement in the computing field.

Also, the emphasis on life-long learning, especially in technical areas, has focused attention on opportunities for advanced coursework for students holding career-oriented associate degrees. In some cases, post-degree certificates have been created in the two-year college environment; in other settings, transition paths have been created into baccalaureate programs. More and more, post-baccalaureate coursework is being completed at two-year colleges as IT-related workers address their needs for continuing education. This phenomenon, together with the enormous demand for workers with technical skills, has shifted the focus for many students away from program completion to pursuing selected course topics and preparation for vendor-specific industry certification.

10. Industry Certification

The intensity of the search for information technology workers has been much enhanced by the specificity of the targeted job market. Employers place advertisements for workers with specific skills for a specific brand and type of hardware and software. Many advertisements placed in newspapers, periodicals, and on the Internet now specify a specific certification credential as a job requirement. Because of the continued shortage of workers, the marketplace offers a wide variety of training and study opportunities to prepare for one of the certification tests. Some workers continue to take all the tests required for a specific credential.

Colleges may implement these guidelines in such a way as to allow the student to target one or more of the vendor-specific or non-vendor-specific certification tests. They may also design the tests toward a broader body of knowledge. These guidelines make no guarantee that students completing the program can pass a specific certification test. They also make no recommendation with respect to the role certification tests should have. Each institution that offers a program based on these guidelines should establish its own mission and purpose, in cooperation with its local needs, to help students best prepare themselves for not only starting a career, but continuing with it. The role of certification testing should be examined, evaluated, and determined by those in charge of implementing the program.

11. Keeping the Curriculum Up To Date

Once institutions implement programs of this nature, they must keep them current to be a meaningful source of employees for IT-related jobs. Colleges should keep plans current through a comprehensive plan that includes ongoing professional growth and development for faculty and staff, continuous curriculum revision, periodic review, assessment and replacement of equipment and associated resources, and ongoing evaluation and updating of instructional methodologies and teaching materials. Such efforts require institutional commitment and support, and must proceed hand-in-hand with advances in technology and in the IT workplace. An active industry advisory council, together with ongoing feedback from graduates and employers, provides an important mechanism to ensure that this occurs. These industry partnerships can provide many forms of support to the two-year college, including curriculum advice, industry training materials, in-service opportunities for faculty, a source of adjunct faculty, equipment donations, supplemental funding, student internships, placement opportunities, and recognition of program excellence.

In addition to measuring the effectiveness and relevance of programs through graduate surveys and industry advisory councils, other means are also available. Such avenues may include institutional accreditation and program certification boards, performance-based measurements such as program completion rates and job placement rates, and student success rates on vendor- or industry-specific certification examinations for programs of that nature.

12. Auxiliary Skills

These guidelines define a knowledge base in computing. However, all graduates will also require knowledge and employability skills derived from a variety of disciplines. Any implementation of these guidelines, therefore, should include assignments, projects, or courses that ensure all graduates will be:

- Skilled in effective writing, speaking (making presentations), and conversing;

- Familiar with mathematics, the social sciences, the arts and humanities, and science, consistent with the usual standards for a liberal arts education;

- Skilled in problem solving and decision making;

- Experienced in interpersonal skills;

- Exposed to techniques of critical analysis and task management; and

- Accustomed to working in teams.

Increasingly, IT has become critical to the operation of many organizations. Workers in this field must demonstrate ethical behavior and professionalism, adhere to codes of conduct, safeguard confidentiality, and respect privacy. Employees must understand the importance of taking responsibility for their actions and being accountable to the organization, and they must be aware of the impact their work has on the entire organization. Any implementation of these guidelines must ensure that graduates can work within this framework.

13. Conclusion

Successful adaptation to community needs will determine the viability of any curriculum offered by an institution. Technology will continue to make changes in all organizations and aspects of society. The recommendations presented in this report are intentionally flexible in anticipation of technological changes. Institutions should feel comfortable modifying these guidelines as the situation dictates.

Part II
PROGRAM TOPICS AND OBJECTIVES

1. Introduction

This part of the report identifies the content areas that two-year colleges should include in programs to prepare graduates for positions in support of computing in a networked environment. A list of topics is given for each content area. A collection of performance objectives in turn details each topic and specifies the breadth and depth of the given topic.

Performance objectives identified with an asterisk (*) constitute *foundation competencies*. We have defined foundation competencies as the common body of knowledge and skills that should be included in *any* associate-degree program based on these guidelines.

2. Content Areas, Goals, Topics, and Performance Objectives

What follows are illustrations of content areas with their associated topics and the expectation of performance as embedded within each topic. Colleges should find these illustrations useful in the development of courses within their computing programs.

2.1 Content Areas, Goals, and Topics

Table 1 contains 19 content areas along with related outcome goals and lists of topics.

Table 1 - Content Areas, Outcome Goals, and Topics

CONTENT AREA	OUTCOME GOALS	TOPICS
Computing within the Organizational Environment	Become familiar with the computing practices and procedures commonly found in organizations.	A. Requirements analysis B. Hardware and software evaluation C. Disaster prevention and recovery D. Ethics and legal issues within the computing environment E. Time and project management F. Employee rights and responsibilities G. Job opportunities and career paths H. Customer service and end-user support
Documentation and Technical References	Create technical documentation and locate necessary online documentation.	A. Technical documents B. System and/or network documentation C. Visual design tools D. Online research
Computer Hardware	Understand, install, and maintain computer hardware.	A. Data representation B. Hardware platforms C. Hardware components D. Installation and maintenance E. Computer organization
Computer Software	Install, configure, and use software.	A. Systems software B. Applications software C. Software installation and configuration D. Programming E. Trends and emerging technologies

Table 1, Continued

CONTENT AREA	OUTCOME GOALS	TOPICS
Troubleshooting	Use trouble-shooting strategies and techniques in correcting a variety of computer hardware and software problems.	A. Diagnostic tools B. Troubleshooting strategies and techniques C. Systems troubleshooting D. Peripherals troubleshooting E. Network troubleshooting
Networking Fundamentals	Identify and understand a variety of network topologies, protocols, and standards.	A. Understanding the networked environment B. Current models and standards C. LAN topologies D. LAN protocols and standards E. Emerging technologies
Network Hardware	Install and configure both client and server networking hardware.	A. Server requirements B. Client requirements C. Transmission media D. Connectivity hardware E. Network storage devices and other peripherals F. Installation and configuration
Network Operating Systems Software	Install and configure both client and server networking software.	A. Server software B. Client software C. Installing and configuring specialized services and devices D. Remote user access
Data Communications	Describe and identify data communications devices, access methods, and protocols.	A. Data communications and telecommunications B. Digital communications C. Communications devices E. Data flow and data codes F. Protocols G. Current issues
Internetworking	Describe various networking settings and their components.	A. WAN topologies B. OSI model C. Internetworking options D. Internetworking software E. Security
Network Administration and Management	Operate networks efficiently and manage them effectively.	A. Network administration B. Performance tuning
Network Design	Undertake effective network design.	A. Physical layout B. Logical layout C. Use of design tools
Internet Structure and Organization	Describe the organization of the Internet and its effect on society.	A. History and organization B. Uses of the Internet C. Issues
Navigating the Internet	Use, install, and configure Internet end-user software.	A. Protocols B. Using the Internet C. Application installation and configuration
Web Authoring	Design and create Web pages.	A. Page design B. Authoring tools C. Accessibility issues D. Page and site development
Web Multimedia	Integrate multimedia onto a Web page.	A. Graphics B. Sound and video C. Virtual reality

CONTENT AREA	OUTCOME GOALS	TOPICS
Web Interactivity	Create a secure and interactive Web page.	A. Security B. Chat rooms and discussion groups C. Forms D. Scripting
Web Site Creation	Set up, manage and secure a Web site.	A. Set up B. Management tools C. Security
Internet Servers	Install and configure Internet servers.	A. Server set up B. Firewalls

2.2 Performance Objectives

In this section, performance objectives for the topics within content areas are presented in a form to facilitate adaptation in a specific two-year college environment. Each content area contains two levels of headings: topics and performance objectives. Performance objectives are the second-level entries. The depth indicator is the leading keyword of each performance objective (e.g., Identify, Evaluate, etc.). For a listing and definition of these depth indicators, see "Taxonomy of Learning Processes" in Section 3 of this Part II. Performance objectives identified with an asterisk (*) constitute foundation competencies.

Computing within the Organizational Environment

A. Requirements Analysis

1. Identify and document user hardware requirements.*
2. Identify and document user software requirements.*
3. Identify and document user requirements for network client hardware, software, and services.*
4. Identify and document user requirements for multimedia hardware and software.
5. Identify and document network server requirements.
6. Identify and document Internet server requirements.

B. Hardware and Software Evaluation

1. Evaluate and recommend hardware products and services.*
2. Apply principles of ergonomics to product selection and recommendation.*
3. Evaluate and recommend peripherals and multimedia products and services.*
4. Evaluate and recommend software products and services.*
5. Evaluate and recommend network servers and operating environments.
6. Evaluate and recommend network and remote access connectivity products and services.
7. Evaluate and recommend the hardware needed for establishing and maintaining a Web site.

C. Disaster Prevention and Recovery

1. Describe appropriate procedures and techniques for disaster prevention and recovery (surge suppressors, UPS, use of anti-virus software, replacement equipment plans, backups of software and data, offsite storage of backup media, etc.).*
2. Describe appropriate security procedures and practices, including physical security and protection of resources through software measures (passwords, anti-virus software, data encryption, etc.).*

D. Ethics and Legal Issues Within the Computing Environment

1. Identify and discuss issues contained within professional codes of conduct.*
2. Identify and discuss software licensing issues.*
3. Identify and discuss property rights and licensing issues.*
4. Identify and discuss privacy issues.*
5. Identify and discuss encryption issues.*
6. Identify legal liability issues.*
7. Identify and discuss issues regarding accessibility for disabled individuals.*

E. Time and Project Management

1. Describe appropriate measures for planning and managing a large project.*
2. Define an implementation schedule for a large project.*
3. Describe appropriate measures for planning and implementing corporate-wide upgrade of hardware and software.*

F. Employee Rights and Responsibilities

1. Discuss employer expectations regarding attendance, punctuality, initiative, teamwork, etc.*
2. Discuss employee rights regarding privacy, discrimination, due process, safety, etc.*
3. Identify potential sources of employee/employer or employee/employee conflict and discuss possible approaches to resolve such disagreements.*
4. Explain the importance of having a written job description.*
5. Use appropriate communication skills, courtesy, manners, and dress in the workplace.*
6. Apply principles and techniques for being a productive, contributing member of a team.*
7. Identify and use acceptable strategies for resolving conflict in the workplace.*
8. Apply principles and techniques for working productively with people of diverse cultures and backgrounds.*

G. Job Opportunities and Career Paths

1. List representative jobs and career paths for people trained in the computer networking support area.*
2. List several functions of each representative computer service oriented job and career path.*
3. Identify techniques for stress management and prevention of job burn-out.*

H. Customer Service and End-user Support

1. Use appropriate communication skills, telephone etiquette, courtesy, and manners when dealing with customers.*
2. Communicate effectively with individuals lacking a technical background.*
3. Give clear detailed technical oral instructions.*
4. Give examples of effective end-user training strategies and techniques.*
5. Assist with end-user training and support.

Documentation and Technical References

A. Technical Documents

1. Use technical vocabulary appropriately.*
2. Read and interpret technical documentation.*
3. Locate information in technical references.*
4. Prepare technical reports.*

B.   System and/or Network Documentation

    1.   Describe appropriate documentation procedures and practices.*
    2.   Effectively use locally maintained systems, software, and network documentation.*
    3.   Produce and maintain system documentation, such as inventory, costs, installed software, and procedures.*
    4.   Maintain network documentation, including server and workstation hardware and software specifications.*
    5.   Document the router configuration.*
    6.   Maintain appropriate documentation of problem resolution for later reference.*

C.   Visual Design Tools

    1.   Effectively use several standard visual modeling tools.*
    2.   Maintain visual network documentation, such as cabling diagrams.*

D.   Online Research

    1.   Describe effective strategies for online research.*
    2.   Locate technical information online.*
    3.   Evaluate information located through online research.*
    4.   Correctly cite Internet-based resources.*

Computer Hardware

A.   Data Representation

    1.   Explain the use of binary numbers to represent instructions and data.*
    2.   Describe the hardware implications of the use of binary representation of instructions and data.*
    3.   Convert numbers among decimal, binary, and hexadecimal representation.*
    4.   Perform binary arithmetic.*
    5.   Identify various coding schemes (ASCII, etc.).*
    6.   Discuss various data types (signed and unsigned integers, floating point, etc).*

B.   Hardware Platforms

    1.   Identify the major hardware platforms.*
    2.   Describe distinguishing features of the major hardware platforms.*
    3.   Set up and use multiple hardware platforms built on various processor architectures.

C.   Hardware Components

    1.   Describe the functions of major hardware components of a computer system.*
    2.   Recognize and correctly identify computing hardware components.*
    3.   Describe emerging hardware technologies and discuss their potential impact.*

D.   Installation and Maintenance

    1.   Implement proper procedures for handling and safeguarding equipment.*
    2.   Perform preventive maintenance tasks on microcomputer systems.*
    3.   Describe procedures for proper disposal of computer components.*
    4.   Set up and configure systems and peripherals. *
    5.   Set up BIOS.*
    6.   Install and configure storage and I/O device interfaces.*
    7.   Install and configure multimedia devices and interfaces.*
    8.   Install and configure network hardware components.*

9. Perform component and system level upgrades.
10. Upgrade BIOS.
11. Completely disassemble and re-assemble a microcomputer system.

E. Computer Organization

1. Describe principles of computer organization as they apply to typical microcomputer equipment.
2. Draw a schematic of a typical microcomputer system.
3. Describe the architecture of a typical microcomputer system.
4. Discuss issues that affect system design and construction (redundancy, fault tolerance, etc.).

Computer Software

A. Systems Software

1. Describe the functions and major components (BIOS, task management, etc.) of a computer operating system.*
2. Identify current operating systems and describe their important features.*
3. Use an operating system for activities such as data and file management.*
4. Identify current systems utilities and describe their functions.*
5. Use system software to perform routine maintenance tasks such as backup, hard drive defragmentation, etc.*
6. Use operating systems of different brands and platforms.
7. Use both stand-alone operating systems and network operating systems.
8. Create, use, and maintain system configuration files.
9. Make configuration changes to an operating system to optimize performance.
10. Transmit and exchange data files in a multiple platform hardware environment.

B. Applications Software

1. Describe the major features and functions of the major categories of applications software (word processing, database, spreadsheet, presentation, e-mail, browsers, etc.).*
2. Use basic features of office productivity software.*
3. Independently learn to perform (previously untaught) tasks using office productivity software.*
4. Use software produced by multiple vendors.*
5. Transmit and exchange data in a multiple vendor software environment.*
6. Use integration features of different office productivity applications software.
7. Use office productivity or other applications software at an advanced-user level.

C. Software Installation and Configuration

1. Install and configure a microcomputer operating system.*
2. Describe procedures for uninstalling operating system software.*
3. Install and configure system software.*
4. Install and configure applications software.*
5. Configure software for accessibility by disabled individuals.*
6. Install and configure applications software upgrades.*
7. Describe modifications necessary to an operating system (such as modifying parameters, how to handle conflicting interrupts, etc.) when installing, configuring and upgrading typical applications software.*
8. Install and configure client software for connecting to LANs, WANs, and the Internet (network client, WWW browser, terminal emulation, file transfer, etc.).
9. Install and configure client software for client/server and network-based applications (e-mail, videoconferencing, database, etc.).
10. Install applications on a server and configure clients for network access.

11. Install and configure applications software at an advanced level, such as one of the following: Computer-Aided Design (CAD), Geographical Information System (GIS), statistical software, desktop publishing, music editing system or game software.
12. Install and configure custom software.

D. Programming

1. Identify several of the most prominent current programming languages.*
2. Characterize the stages of the system development life cycle.*
3. Differentiate between two common strategies for problem solving.*
4. Describe the program design and development process.*
5. Differentiate between structured programming and object-oriented programming.*
6. Use procedural and object-oriented constructs of programming, scripting, and/or macro languages to create and test programs including batch files and menu programs. *
7. Apply principles of good design and documentation when developing programs.*

E. Trends and Emerging Technologies

1. Name several emerging software technologies.*
2. Describe the potential impact of the named emerging software technologies.*

Troubleshooting

A. Diagnostic Tools

1. Describe the use of diagnostic test equipment.*
2. Describe features of diagnostic software.*
3. Use system, software, and network documentation.*
4. Locate and use online documentation resources.*

B. Troubleshooting Strategies and Techniques

1. Describe effective troubleshooting strategies and techniques to resolve basic hardware problems.*
2. Describe effective troubleshooting strategies and techniques to resolve basic software problems.*
3. Describe effective troubleshooting strategies and techniques to resolve basic network problems.*

C. Systems Troubleshooting

1. Recognize and resolve basic hardware problems.*
2. Recognize and resolve basic software configuration problems.*
3. Recognize and resolve system level software conflicts (e.g., IRQ conflicts).
4. Recognize and resolve problems originating from software interaction.
5. Recognize and resolve problems originating from software/hardware interaction.
6. Isolate and replace faulty components (board level only).
7. Use effective troubleshooting strategies and techniques to resolve system problems.
8. Effectively use appropriate research tools to locate information needed to solve system problems.
9. Perform systems troubleshooting tasks on multiple platforms

D. Peripherals Troubleshooting

    1.   Recognize and resolve basic printer problems.*
    2.   Identify resources for resolving peripheral device problems.*
    3.   Use effective troubleshooting strategies and techniques to resolve problems with peripheral devices and/or drivers, including I/O, multimedia, storage, and remote access devices.
    4.   Effectively use appropriate research tools to locate information needed to solve problems with peripheral devices.

E. Network Troubleshooting

    1.   Identify effective troubleshooting techniques to resolve basic network problems.*
    2.   Recognize and resolve basic network problems.*
    3.   Use effective troubleshooting strategies and techniques to resolve network problems, including network interfaces, cabling, or other network components (hubs, switches, etc.).
    4.   Use sniffers, cable testers, and other network troubleshooting tools.
    5.   Use utilities such as ping, telnet, and trace route in testing a network.
    6.   Test WAN links using loopback techniques.
    7.   Recognize and resolve complex network problems, including installation and configuration of server, client, NIC, cable, hub, and/or network peripherals.
    8.   Recognize and resolve problems originating from interaction of network components.
    9.   Effectively use appropriate research tools to locate information needed to solve network problems.

Networking Fundamentals

A. Understanding the Networked Environment

    1.   Give several advantages and disadvantages of networked and non-networked environments.*
    2.   Describe current network environments, such as peer-to-peer and client/server.*
    3.   Identify and discuss issues (such as security, privacy, redundancy, etc.) related to networked environments.*
    4.   Identify and discuss issues related to naming conventions for user-ids, e-mail, passwords, and network devices.*

B. Current Models and Standards

    1.   List and define layers in the OSI and TCP/IP network protocol models.*
    2.   Identify and describe current relevant IEEE network standards.*

C. LAN Topologies

    1.   Illustrate typical network topologies.*
    2.   Identify advantages and disadvantages of each topology.*

D. LAN Protocols and Standards

    1.   Describe the major functions of LAN hardware protocols such as ethernet, token ring, FDDI, and arcnet.*
    2.   Describe LAN software protocols such as IPX/SPX, TCP/IP, and NetBEUI.*
    3.   Discuss the nature of IP addresses and MAC addresses, and mapping between protocol addressing schemes.*

E. Emerging Technologies

    1.   Identify major emerging technologies (such as ATM, VPN, and voice over IP).
    2.   Identify and discuss technical issues related to emerging technologies (such as security, bandwidth capability, and gigabit transmission rates).
    3.   Discuss the design and function of a storage-area network (SAN).

Network Hardware

A. Server Requirements

    1.   Describe the major functions of network server hardware components.*
    2.   Describe server hardware requirements.*
    3.   Describe the hardware needed for hosting a Web site.
    4.   Identify a variety of specialized servers (e.g. proxy, e-mail, DHCP, Web, etc.)
    5.   Describe the hardware requirements for specialized servers (such as e-mail, database).

B. Client Requirements

    1.   Describe the major functions of network client hardware components.*
    2.   Describe client hardware requirements.*

C. Transmission Media

    1.   Differentiate between hardware used to implement different topologies such as token ring and ethernet.*
    2.   Recognize and describe current cable technologies such as twisted-pair, coaxial, and fiber optic, and identifying issues associated with plenum verses non-plenum cable plants.*
    3.   Describe current wireless technologies such as satellite, microwave, spread spectrum RF, and infrared.*
    4.   Identify advantages and disadvantages of wireless and cable technologies.*
    5.   Cite appropriate uses of wireless and cable technologies.*

D. Connectivity Hardware

    1.   Describe the major functions of network connectivity hardware, such as hubs, repeaters, bridges, routers, switches, and gateways.*
    2.   Describe the hardware needed to connect a LAN to the Internet.*

E. Network Storage Devices and Other Peripherals

    1.   Describe the function of network storage devices and other peripherals (RAID, CD towers, printers, fax machines, scanners, printer/fax/copiers, imaging devices, and document center equipment, etc.).*
    2.   Describe the requirements for connecting peripherals directly to a network.

F. Installation and Configuration

    1.   Set up and configure a server (including installation of NICs and NIC drivers).*
    2.   Set up and configure client hardware (including installation of NICs and NIC drivers).*
    3.   Set up network storage devices and other peripherals and connect to the network.*
    4.   Fabricate patch cables.
    5.   Set up a network using cable technology.
    6.   Set up a network using wireless technology.
    7.   Use current connectivity devices such as hubs, repeaters, bridges, routers, switches, and gateways.

Network Operating Systems Software

A.   Server Software

    1.   Describe the major functions of network server software components.*
    2.   Compare and contrast major functions and features of current network operating systems (including directory services).*
    3.   Install and configure a LAN server.*
    4.   Install and configure drivers for NICs and network peripherals.*
    5.   Configure protocol stacks.*
    6.   Configure a server for multiple network protocols and frame types.
    7.   Configure a server to handle multiple languages for international applications.
    8.   Set up and configure network routing, using appropriate documentation.
    9.   Describe management issues and procedures for handling multiple servers on a network.
    10.   Install and connect multiple servers (including different platforms).
    11.   Install and configure anti-virus software.
    12.   Install and configure client-auditing software.
    13.   Install and configure software to build client-side images.

B.   Client Software

    1.   Describe the major functions of network client software components.*
    2.   Install and configure client software on multiple hardware platforms.*
    3.   Install and configure drivers for NICs and network peripherals (including printers).*
    4.   Configure the client to support multiple protocols.*

C.   Installing and Configuring Specialized Services and Devices

    1.   Install and configure client/server applications (such as e-mail, scheduling, etc) on a server.
    2.   Install and configure network-based services such as videoconferencing, integrated voicemail/email/fax, large document storage and retrieval, etc.
    3.   Set up a proxy server and a gateway.

D.   Remote User Access

    1.   Set up a server for remote access.
    2.   Address security issues raised by the ability to access server remotely.
    3.   Discuss the functions of authentication servers, RADIUS, and VPN.

Data Communications

A.   Data Communications and Telecommunications

    1.   Differentiate between telecommunications and data communications.*
    2.   Describe the main functions of each relevant current standard setting organization (IEEE, TIA, etc.).

B.   Digital Communications

    1.   Compare and contrast digital communications lines and cable characteristics (e.g. ISDN, DSL, T-1 and T-3).
    2.   Describe ATM technology; discuss the functions and applications of this technology.

C.   Communications Devices

    1.   Describe the functioning of modems, their features and operating characteristics.*
    2.   Define the features of an ASCII terminal.
    3.   Describe the function of a UART.

D.   Data Flow and Data Codes

    1.   Discuss signal representation and modulation.
    2.   Describe current data code systems used in data communication.
    3.   Compare and contrast synchronous and asynchronous serial transmission.
    4.   Compare and contrast major data communications media in terms of data flow, data codes, and transmission codes.
    5.   Define common error detection and correction mechanisms.

E.   Access Control Methods

    1.   Identify LAN access control methods (CSMA/CD, token passing, etc.).
    2.   Compare and contrast the major features of the LAN access methods.

F.   Protocols

    1.   Describe asynchronous protocols.
    2.   Describe synchronous serial link protocols.
    3.   Identify and describe file transfer protocols and methodologies.

G.   Current Issues

    1.   Describe data compression methodologies used for file transfer.
    2.   Identify evolving issues, such as gigabit transmission requirements, voice over IP, and wireless technologies.

Internetworking

A.   WAN Topologies

    1.   Describe WAN topologies and MAN topologies.
    2.   Differentiate between WAN topologies and LAN topologies.
    3.   Compare and contrast routing protocols (e.g., RIP, OSFP).
    4.   Describe the general routing problem and common solutions (including routing verses bridging).

B.   OSI Model

    1.   Identify and describe WAN protocols.
    2.   Explain how the first three layers of the OSI model relate to routing and switching.
    3.   Describe various routing protocols such as RIP, OSPF.

C.   Internetworking Options

    1.   Differentiate among routing, switching and bridging.
    2.   Install routers to simulate a WAN/LAN network.
    3.   Explain each step necessary for connecting a network to the Internet.
    4.   Explain the differences between connecting to the Internet via a dial-up connection vs. a dedicated connection.
    5.   Identify two major network issues associated with each of Internet, intranet, and extranet.
    6.   Implement LAN/WAN connections, including virtual private networks (VPN), permanent virtual circuits (PVC), frame relay, tunneling, remote and mobile user access, etc.

D.   Internetworking Software

    1.   Define the basic software components of a WAN.
    2.   Configure routers to simulate a WAN/LAN network.
    3.   Explain the function and purpose of firewalls and firebreaks and their purpose.
    4.   Configure access lists to limit traffic and enhance security.

E.   Security

    1.   Explain three major security concerns relating to data communications.
    2.   Describe current encryption standards - public vs. private key, NSA DES, PGP.
    3.   Describe the functions and characteristics of firewalls.

Network Administration and Management

A.   Network Administration

    1.   Implement appropriate procedures for maintaining network security.
    2.   Manage user accounts, including login scripts.
    3.   Design, set up, and maintain server directory structure.
    4.   Assign users appropriate rights to files, applications, and resources.
    5.   Use a network accounting system.
    6.   Perform backup and recovery procedures and validation.
    7.   Discuss the issues associated with single sign-on, password synchronization, and user authentication.

B.   Performance Tuning

    1.   Configure time synchronization and troubleshoot inconsistencies.
    2.   Optimize network servers.
    3.   Describe the function of commonly used network management tools.
    4.   Effectively use network management tools to integrate and manage network resources.
    5.   Explain RMON and SNMP and their use in monitoring a network.
    6.   Demonstrate the use of a network management package.
    7.   Prepare a baseline of network utilization for future reference.
    8.   Use baseline data compare to locate possible problems in a network experiencing difficulty.
    9.   Configure network devices to send SNMP traps or alerts to network management systems.
    10.   Discuss quality-of-service considerations and switching prioritization.
    11.   Describe routing metrics such as hop counts, cost, etc.
    12.   Describe typical WAN links and discuss bandwidth considerations.
    13.   Give examples of WAN backup techniques such as dial-backup that illustrate when they are appropriate.

Network Design

A. Physical Layout

    1.   Design a LAN, including the specification of architecture, hardware, software, etc.

B. Logical Layout

    1.   Identify the advantages of VLANs.
    2.   Characterize a VLAN implementation.
    3.   Describe the function of a spanning tree algorithm.
    4.   Identify a proper network design with a spanning tree component.

C. Use of Design Tools

    1.   Effectively use two different and current network modeling tools.
    2.   Produce effective documentation.

Internet Structure and Organization

A.   History and Organization

    1.   Describe the origin of the Internet.*
    2.   Outline the history of the Internet.*
    3.   Describe Internet organization, such as the Internic, domains and requests for comments (RFCs).*
    4.   Describe the structure of the Internet.*
    5.   Differentiate between the Internet and the WWW.*

B.   Uses of the Internet

    1.   Define Internet push technologies, such as e-mail marketing vs. Web page banner advertising.*
    2.   Describe Web e-commerce.*
    3.   Differentiate among an Intranet site, an Extranet site, and an Internet site.*

C.   Issues

    1.   Characterize the role of the Internet in today's society.*
    2.   Describe several major ethical issues related to Internet use.*
    3.   Identify several legal issues related to Internet use.*
    4.   Give several examples to show how the Internet has affected intellectual property rights.*
    5.   Give several examples to show how the Internet has affected personal security and privacy.*
    6.   Describe the World Wide Web (WWW).*
    7.   Give several examples to show how the WWW has affected our society.*

Navigating the Internet

D.   Protocols

    1.   Demonstrate the use of typical file types and protocols (http:, ftp:, mailto:, gopher:, telnet:, etc.).*
    2.   Demonstrate the use of typical remote access mechanisms.*
    3.   Differentiate among all valid WWW file types.
    4.   Differentiate among all WWW multimedia file types.

E.   Using the Internet

    1.   Describe components of URL and their meanings (including types).*
    2.   Effectively use Internet tools and utilities such as e-mail, browsers, search engines, news groups, list serves, chat rooms, file transfers.*

F.   Application Installation and Configuration

    1.   Install and configure an Internet browser.*
    2.   Install and configure browser add-ons and plug-ins.*
    3.   Install and configure a newsgroup reader.
    4.   Install and configure a chat group client.

Web Authoring

G.   Page Design

    1.   Describe the Human-Computer Interaction (HCI) factors that impact the design of a Web page and Web site.*
    2.   Describe and use the process of storyboarding a Web site.*
    3.   Describe format, structure and design principles for Web sites.*
    4.   Evaluate Web sites using principles of good format, structure, and design.*

H.   Authoring Tools

    1.   List several Web authoring tools in order of complexity of use.*
    2.   Evaluate software for Web page authoring.
    3.   Install and configure a Web page authoring tool.

I.   Accessibility Issues

    1.   Describe handicapped-accessibility features for a Web site.*
    2.   Evaluate a Web site for handicapped accessibility.*

J.   Page and Site Development

    1.   Create a Web page using authoring tools.*
    2.   Use current Web programming languages to create and maintain a Web page.*
    3.   Incorporate an e-mail link on a Web page.
    4.   Incorporate internal and external links on a Web page.
    5.   Incorporate frames on a Web page.
    6.   Incorporate tables on a Web page.
    7.   Incorporate handicapped-accessibility options into the Web site.
    8.   Incorporate file transfer capabilities from a Web page.
    9.   Design and create a Web site.
    10.   Set up and configure a search engine for a Web site.
    11.   Set up and configure an e-commerce Web site.
    12.   Set up and configure online catalog to market products.

Web Multimedia

K.   Graphics

    1.   Evaluate Web graphic utilities and creation tools, including those for animated graphics.
    2.   Incorporate standard graphics into a Web page.
    3.   Incorporate animated graphics into a Web page.

L.   Sound and Video

    1.   Incorporate sound files onto a Web page.
    2.   Incorporate a streaming video file onto a Web page.
    3.   Incorporate a video file for download into a Web page.
    4.   Create an animated graphic.
    5.   Perform simple graphic modifications using a graphics utility.

M.   Virtual Reality

    1.   Create virtual Web pages using a virtual reality modeling language.

Web Interactivity

N.   Security

    1.   Incorporate password protection on a Web page.
    2.   Incorporate Internet cookies into a Web page.

O.   Chat Rooms and Discussion Groups

    1.   Configure and host a chat room.
    2.   Incorporate a chat room onto a Web page.
    3.   Establish an asynchronous discussion group.
    4.   Incorporate an asynchronous discussion group onto a Web site.

P.   Forms

    1.   Create a Web form and produce e-mail results.
    2.   Create a Web database interface.
    3.   Discuss the issue of ODBC compliance.
    4.   Create a Web shopping cart and allow for Web invoicing.

Q.   Scripting

    1.   Write scripting code to handle error checking in client forms.
    2.   Write CGI programs to allow for interactions between the client and server.
    3.   Write Java applets.

Web Site Creation and Management

R.   Setup

    1.   Describe the process of obtaining an Internet domain address.
    2.   Register an Internet site.
    3.   Notify appropriate external search engines of the Web site.

S.   Management Tools

    1.   Compare features of currently available site management tools.
    2.   Install and configure Web site management software.
    3.   Create and maintain a Web site using a Web management tool.

T.   Security

    1.   Implement appropriate Web site security measures.
    2.   Use and evaluate the results of a Web site visit recording tool.

Internet Servers

U. Server Setup

    1. Install and configure a Web server.
    2. Install and configure a proxy server.
    3. Install and configure a list-serve server.
    4. Install and configure a chat server.
    5. Install and configure a news group server.
    6. Install and configure a secure e-commerce server.

V. Firewalls

    1. Explain the need for and function of, an Internet firewall.
    2. Implement an Internet firewall.

3. Taxonomy of Learning Processes

Table 2 is an adaptation of Bloom's Taxonomy. It shows the taxonomy levels in ascending order with a definition for each level. The table also includes verbs that may be useful in the design of course activities.

Table 2 - Bloom's Taxonomy, Modified

LEVEL OF TAXONOMY	DEFINITION	VERBS TO HELP DESIGN ACTIVITIES
Factual Knowledge	Recall information	Tell – list – define – name – recall – identify – remember – repeat – recognize
Comprehension	Understanding of communicated material or information	Transform – change – restate – describe – explain – interpret – summarize – discuss
Applicative Knowledge	Apply basic rules and conventions	Add – subtract – punctuate – edit – divide – multiply – diagram
Procedural Knowledge	Complete tasks using multi-step processes	Apply – investigate – produce
Analysis	Breaking down information into its parts	Analyze – dissect – distinguish – examine – compare – contrast – survey – categorize
Synthesis	Putting together ideas into a new or unique product	Create – invent – compose – construct – design – produce – modify
Evaluation	Judging the value of materials or or ideas based on set standards or criteria	Judge – decide – justify – evaluate – critique – debate – verify – recommend
Higher-Order Thinking	Apply analysis, syntheses and evaluation processes to solve complex problems	Evaluate – create – conduct – analyze
Attitudes and Values	Express feelings, opinions, personal beliefs regarding people, objects and events	Respect – demonstrate – express
Social Behaviors	Learned behavior that conforms to acceptable social standards	Perform – communicate
Motor Skills	Physical coordination, strength, control, skills related to physical tasks	Demonstrate – run – dribble – move – show

Part III
SAMPLE SPECIALITY PROGRAMS

1. Introduction

The collection of content areas, topics, and performance objectives can be packaged a variety of ways to address different degree and certificate programs. Among these possibilities are specialty associate-degree programs in *User Support Services*, *Networking Services*, and *Internet/Web Services*. This part of the report suggests content areas and objectives for the technical component of these sample specialty programs. A variety of implementations are possible based on local needs; therefore these guidelines provide a framework rather than prescriptive course listings for any specific implementation.

2. Topics and Objectives by Sample Program

This section details the technical-specific content areas, topics, and performance objective for the three sample specialty programs. A specific implementation by a two-year college should be packaged into courses that include all of the recommended performance objectives for the given program. In addition, each implementation should include courses to satisfy the college's general education requirements; related program electives in areas such as business, mathematics, and statistics; and sufficient other electives for the requisite credit hour total needed for an associate-degree program. The combination of general education and elective courses should provide the auxiliary skills that are specified in Part I of this report.

Tables 3-5 delineates the technical components recommended for an implementation of the sample specialty program. Column 1 lists all 19 content areas. Column 2 indicates which topics should be included for the given content area. Column 3 identifies the performance objectives to be included for the given topic. Within column 2, the word *all* specifies that all topics are to be included for the given content area. Likewise, within column 3, the word *all* specifies that all performance objectives are to be included for the given topic.

Program 1
User Support Services
(Associate Degree)

This program provides depth and breadth in areas related to hardware and software installation, configuration, troubleshooting, and customer service. The program prepares students for jobs such as Help Desk Specialist, PC Technician, Microcomputer Technician, Technical Support Specialist and Customer Service Representative for computing firms. Table 3 details the recommended technical component for this program.

Table 3 - Technical Component for User Support Services

CONTENT AREA	SELECTED TOPICS	SELECTED OBJECTIVES
Computing within the Organizational Environment	All	All
Documentation and Technical References	All	All
Computer Hardware	All	All
Computer Software	All	All
Troubleshooting	A. Diagnostic Tools B. Troubleshooting strategies and techniques C. Systems troubleshooting D. Peripherals troubleshooting E. Network troubleshooting	All All All All 1-6
Networking Fundamentals	A. Understanding the networked environment B. Current models and standards C. LAN topologies D. LAN protocols and standards	All All All All
Network Hardware	A. Server requirements B. Client requirements C. Transmission media D. Connectivity hardware E. Network storage devices and other peripherals F. Installation and configuration	1-2 All All All 1 1-3
Network Operating Systems Software	A. Server software B. Client software	1-5 All
Data Communication	A. Data communications and telecommunications B. Communications devices	 1 1
Internetworking	None	None
Network Administration and Management	None	None
Network Design	None	None
Internet Structure and Organization	All	All
Navigating the Internet	A. Protocols B. Using the Internet C. Application installation and configuration	1-2 All 1-2
Web Authoring	A. Page design B. Authoring tools C. Accessibility issues D. Page and site development	All 1 All 1-2
Web Multimedia	None	None
Web Interactivity	None	None
Web Site Creation and Management	None	None
Internet Servers	None	None

Program 2
Networking Services
(Associate Degree)

This program provides depth and breadth in areas related to installing, configuring, monitoring, troubleshooting, and managing a LAN. The program prepares students for jobs such as Network Cabling Specialist, Network Technician, Network Troubleshooter, and Network Administrator. Table 4 details the recommended technical component for this program.

Table 4 – Technical component for Networking Services

CONTENT AREA	SELECTED TOPICS	SELECTED OBJECTIVES
Computing within the Organizational Environment	A. Requirements analysis B. Hardware and software evaluation C. Disaster prevention and recovery D. Ethics and legal issues within the computing environment E. Time and project management F. Employee rights and responsibilities G. Job opportunities and career paths H. Customer service and end-user support	All All All All All All All 1-4
Documentation and Technical References	All	All
Computer Hardware	A. Data Representation B. Hardware platforms C. Hardware components D. Installation and maintenance	All 1-2 All 1-8
Computer Software	A. Systems software B. Applications software C. Software installation and configuration D. Programming E. Trends and emerging technologies	1-8 1-5 1-10 All All
Troubleshooting	A. Diagnostic Tools B. Troubleshooting strategies and techniques C. Systems troubleshooting D. Peripherals troubleshooting E. Network troubleshooting	All All 1-2 All 1-4
Networking Fundamentals	All	All
Network Hardware	All	All
Network Operating Systems Software	All	All
Data Communications	All	All
Internetworking	All	All
Network Administration and Management	All	All
Network Design	All	All
Internet Structure and Organization	All	All
Navigating the Internet	A. Protocols B. Using the Internet C. Application installation and configuration	1-2 All 1-2
Web Authoring	A. Page design B. Authoring tools C. Accessibility issues D. Page and site development	All 1 All 1-2
Web Multimedia	None	None
Web Interactivity	None	None
Web Site Creation and Management	None	None
Internet Servers	None	None

Program 3
Internet/Web Services
(Associate Degree)

This program provides depth and breadth in areas related to installing, configuring, designing, and managing Internet and Web-based resources. The program prepares students for jobs such as Web Manager, Web Site Developer, Web Page Designer and Internet Support Specialist. Table 5 details the recommended technical component for this program.

Table 5 - Technical Component for Internet/Web Services

CONTENT AREA	SELECTED TOPICS	SELECTED OBJECTIVES
Computing within the Organizational Environment	A. Requirements analysis B. Hardware and software evaluation C. Disaster prevention and recovery D. Ethics and legal issues within the computing environment E. Time and project management F. Employee rights and responsibilities G. Job opportunities and career paths H. Customer service and end-user support	All All All All All All All 1-4
Documentation and Technical References	All	All
Computer Hardware	A. Data Representation B. Hardware platforms C. Hardware components D. Installation and maintenance	All 1-2 All 1-8
Computer Software	A. Systems software B. Applications software C. Software installation and configuration D. Programming E. Trends and emerging technologies	1-8 1-5 1-10 All All
Troubleshooting	A. Diagnostic Tools B. Troubleshooting strategies and techniques C. Systems troubleshooting D. Peripherals troubleshooting E. Network troubleshooting	All All 1-2 1-2 1-3
Networking Fundamentals	A. Understanding the networked environment B. Current models and standards C. LAN topologies D. LAN protocols and standards	All All All
Network Hardware	A. Server requirements B. Client requirements C. Transmission media D. Connectivity hardware E. Network storage devices and other peripherals F. Installation and configuration	All All All All 1 1-3
Network Operating Systems Software	A. Server software B. Client software C. Installing and configuring specialized services and devices D. Communications devices	1-7 All All All
Data Communications	A. Data communications and telecommunications B. Communications devices	1 1
Internetworking	None	None
Network Administration and Management	None	None
Network Design	None	None

Table 5, Continued

CONTENT AREA	SELECTED TOPICS	SELECTED OBJECTIVES
Internet Structure and Organization	All	All
Navigating the Internet	All	All
Web Authoring	All	All
Web Multimedia	All	All
Web Interactivity	All	All
Web Site Creation and Management	All	All
Internet Servers	All	All

3. **Comparison of Sample Specialty Programs**

For each of the 19 content areas, Table 6 lists the total number of performance objectives, the number of performance objectives that are foundation competencies, and the number of performance objectives appearing in each of the sample specialty programs.

Table 6 - Program Comparisons

CONTENT AREA	TOTAL NUMBER OF OBJECTIVES	FOUNDATION COMPETENCIES	USER SUPPORT SERVICES	NETWORKING SERVICES	INTERNET/WEB SERVICES
Computing within the Organizational Environment	41	34	41	40	40
Documentation and Technical Reference	16	16	16	16	16
Computer Hardware	27	19	27	19	19
Computer Software	38	26	38	32	32
Troubleshooting	29	13	26	17	14
Networking Fundamentals	14	11	11	14	11
Network Hardware	23	15	15	23	18
Network Operating Systems Software	23	9	9	23	17
Data Communications	19	2	2	19	2
Internetworking	20	0	0	20	0
Network Administration and Management	20	0	0	20	0
Network Design	7	0	0	7	0
Internet Structure and Organization	15	15	15	15	15
Navigating the Internet	10	6	6	6	10
Web Authoring	21	9	9	9	21
Web Multimedia	9	0	0	0	9
Web Interactivity	13	0	0	0	13
Web Site Creation and Management	8	0	0	0	8
Internet Servers	8	0	0	0	8

Part IV
SUPPORTING INFORMATION

Task Force

The ACM Two-Year College Education Committee formed a Task Force for the purpose of formulating these guidelines. The Task Force members are:

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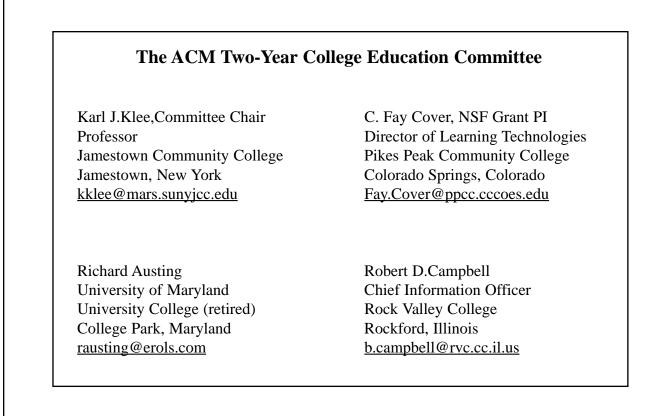Westnet, *Networx Computer Networking Curriculum* (1999), <http://www.westnetinc.com/>.

THE ACM TWO-YEAR COLLEGE EDUCATION COMMITTEE

Committee Charter:
The Two-Year College Education Committee is a standing committee of the ACM Education Board (since September, 1991). The Committee is concerned with all education issues that affect computing at two-year colleges and in two-year degree programs. The primary purpose of the Committee is to provide curriculum recommendations in all areas of computing for such degree programs. The Committee may also make recommendations on other educational matters affecting such programs.

Committee Membership:
In May 2000, the membership of the Committee consisted of the following individuals.

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Committee Communications:
The Committee interacts with two-year college computing professionals through several means, including a web site dedicated to Committee activities and information that is accessible via the ACM website <www.acm.org/education/>.

The ACM Two-Year College Education Committee solicits input on its work, recruits individuals to assist with Committee activities, and periodically distributes mailings. Furthermore, we are particularly interested in feedback on this Report as well as the identification of institutions that have implemented programs associated with these Guidelines.

To these ends, we encourage you to provide us with your information.

ACM Two-Year College Education Committee Database Form

Name: _____

Title/Position: _____

Responsibilities: _____

Department / Division: _____

College: _____

Address: _____

_____

Phone Number: _____ FAX Number: _____

E-Mail: _____

_____ I am interested in participating in the activities of the Committee.

_____ Please send me information about ACM membership.

_____ We have implemented a degree program associated with these guidelines.
Details may be found at the following URL: _____

Please complete this form online at <http://www.acmtyc.org>, or postal to:

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