Guidelines for Associate-Degree Programs

Information Systems

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Produced by the

ACM Two-Year College Education Committee

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Contents

Section 1

Introduction

1.1 Purpose

This report provides a framework for the development, support, and updating of associate-degree programs in the computing discipline of Information Systems (IS). Graduates of such programs should be able to transfer into the upper division of an IS baccalaureate-degree program or pursue a career in the IS field in an entry-level position. These guidelines will assist colleges in educating potential IS workers in technical computing competencies, as well as necessary workplace skills. Graduates of programs crafted from these guidelines should be able to:

- Apply computing skills to solve problems within the context of business systems;
- Communicate effectively within an organization;
- Work productively in team and individual settings;
- Demonstrate professionalism and ethical behavior; and
- Adapt to emerging technologies and new environments.

1.2 Background

The Association for Computing Machinery (ACM), the First Society of Computing, has supported for many years curriculum development and improvement. In 1993, the ACM Two-Year College Education Committee (ACM TYCEC) released its curriculum guidelines entitled *Computing for Information Processing* (CIP), as part of a four-volume set of curricular guidelines directed specifically to the associate-degree granting institutions. The CIP report outlined a collection of knowledge units with associated depth indicators that were organized into sample courses.

The *IS 2002 Model Curriculum and Guidelines for Undergraduate Degree Programs in Information Systems*, a joint production of the ACM, the Association for Information Systems (AIS), and the Association of Information Technology Professionals (AITP), was released in 2002 and was targeted to baccalaureate programs. In 2003, the ACM TYCEC organized a task force to produce a new information systems report for the two-year colleges, as both an update to the 1993 CIP report and a bridge to the IS 2002 report. The *Guidelines for Associate-Degree Programs in Information Systems* is the result of the work of this task force, together with reviews from business and academe across the United States and Canada.

1.3 Structure of this Report

This report provides guidelines for the implementation and sustenance of an associate-degree program in information systems. The *Program Considerations* section provides context for two-year college programs in the field of Information Systems; the *Body of Knowledge* section addresses curriculum content in course-based groupings.

Section 2

Program Considerations

2.1 The Two-Year College Environment

A variety of factors arises from the threefold educational mission of the two-year college environment. These institutions prepare students for:

- Entrance into the local workforce;
- Lifelong learning for personal and professional enrichment; and
- Transfer into baccalaureate programs.

In addition, many two-year colleges are facilitators of local economic development and the sources of a wide range of community events, activities, and services.

Two-year colleges serve high school graduates proceeding directly into college. It also serves workers needing to upgrade skill sets or master new ones in order to re-enter the workforce. Another contribution is its service to immigrants seeking to become integrated into the local culture and master a new language, individuals leaving the workplace to engage college-level coursework for the first time, returning students with college degrees who have decided to pursue an alternate career path, and many individuals in need of ongoing training and skill updating. Two-year colleges address this diversity in numerous ways, including targeted career counseling, remediation of basic skills, specialized course offerings, individualized instruction and attention, flexible scheduling and delivery methodologies, and a strong emphasis on retention and successful completion. Furthermore, because two-year colleges typically have less restrictive entrance requirements, faculty must be prepared to instruct students exhibiting a wide range of academic preparations, aptitudes, and learning styles.

2.2 Sustaining a Program

Administration and leadership at two-year colleges must be prepared to provide adequate support for information systems programs. Two-year colleges must fund the resources and professional activities necessary to sustain these programs. These include:

- Sufficient number of qualified faculty;
- Plans for development, implementation, evaluation, and revision of curriculum by faculty;
- Opportunities for ongoing professional growth and development of faculty and support staff;
- Industry involvement through an industry advisory committee empowered to influence decisions and impact the program;
- State-of-the-art computer classrooms, laboratories, and facilities dedicated to specialized instruction in information systems courses;
- Adequate office space equipped with current hardware and software resources for faculty and support staff
- Staffing support for infrastructure needs including computer maintenance;
- End-user support for students and faculty; and
- Regular updating, enhancement, and replacement of computing hardware and software.

Recruiting, hiring, and retaining qualified full-time faculty is often a challenge for two-year colleges. It may be necessary to make extensive use of adjunct and part-time faculty, who often provide specific technical skills and teaching techniques for specialized courses. However, the recruitment, development, evaluation, and retention of talented adjunct faculty require a commitment of institutional financial resources, as well as the time of faculty and staff.

The institution must plan for the necessary staffing of laboratory facilities and the maintenance of computer hardware and software. Institutions need a qualified and adequate staff to address the technical, clerical, and facility management functions. Issues such as salary, professional development, and access to current technology apply to these critical support personnel as well.

Colleges should keep programs current by means of a comprehensive plan that includes ongoing professional growth and development for both full-time and adjunct 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 learning materials. Two-year colleges must accurately and effectively measure student learning with associated outcomes. Accreditation requirements, performance-based funding and public demands for accountability have made effective educational assessment a necessity.

Two-year colleges must establish and maintain effective working relationships with local business and industry, especially potential employers of information systems graduates. 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. Along with ongoing feedback from graduates and employers, an active industry advisory council provides an important mechanism to ensure that such activities occur.

2.3 Articulation of Transfer Programs

Articulation of courses and programs between academic institutions facilitates the transfer of students from one institution to the other. The goal is to enable students to transfer in as seamless a manner as possible. Efficient and effective articulation requires accurate assessment of courses and programs as well as meaningful communication and cooperation. Students and faculty both have responsibilities and obligations for successful articulation.

A two-year college must develop transition and articulation strategies for the colleges and universities to which its students most often transfer. It may be necessary to modify course content to facilitate transfer credit and articulation agreements. In some cases, it may be necessary for a two-year college to modify its list of recommended courses to match the requirements of the primary transfer institutions. A student's program of study must also take into consideration the general education requirements at both the two-year college and the anticipated transfer institution.

Students must realize that courses and program requirements change over time. If a student takes an extended time to complete a program, a different articulation agreement may be in effect at the time the student requests to transfer. Hence, students must expect to complete programs in their entirety up to well-defined exit points (e.g., completion of a defined course sequence, certificate, or degree) at one institution before transferring to another institution; one cannot expect articulation to accommodate potential transfers in the middle of a carefully designed curriculum. In addition, students that graduate from career-oriented associate-degree programs may decide once they have gained work experience to pursue a baccalaureate degree; such individuals should be aware that they might have to take additional courses before entry into the upper division.

Faculty must ensure that they clearly define program requirements, responsibly address program objectives, and effectively evaluate students against defined standards. Articulation agreements should specify one or more well-defined exit points for students to matriculate from the two-year college to the transfer institution. In turn, faculty at the upper division institution must provide any transitional preparation necessary to enable transfer students to continue their academic work on par with students at the baccalaureate institution.

2.4 Career-oriented Programs

A career-oriented associate degree program in Information Systems provides the specific knowledge, skills, and abilities necessary to proceed directly into the workplace. At the earliest opportunity, faculty and academic advisors must help each student determine which type of program best addresses the student's goals. Such considerations include the distinctions between career and transfer programs, the academic requirements of each, and the associated employment options. Students graduating from a career-oriented associate degree program in Information Systems may enter the workforce with job titles such as:

- Database programmer, database administrator, database manager, records manager;
- Systems administrator, network administrator, network specialist;
- Technical writer, documentation specialist;
- Technical support specialist, help desk specialist;
- E-business specialist, e-commerce specialist;
- Web designer, web specialist, web developer, webmaster, instructional designer;
- Programmer, applications programmer, programmer/analyst, information systems developer, software tester;
- Business process specialist, business automation specialist; and
- Computer sales associate.

The following factors help ensure the success of students in the workplace and the viability of a career-oriented information systems degree program.

- An active information systems industry advisory committee consisting of prospective employers to provide guidance concerning the knowledge, skills, and abilities the students must possess to enter directly into a career in information systems within their community;
- Real-world work experience including co-op programs, internships and/or other practicum activities, with an emphasis on professional practices;

- Core and elective coursework as recommended by advisory committees;
- Potential articulation paths that enable the career-oriented student to pursue a baccalaureate degree in the future after working for some period of time; and
- Assessment processes whereby students can earn credit for relevant experience.

2.5 Incorporating Professional Practices

Faculty at two-year colleges must remain aware of the importance of including professional practices and applied work as an integral part of all computing programs. IS students should be encouraged to:

- Work in teams;
- Use techniques of task and time management;
- Solve practical problems in course projects;
- Make presentations;
- Confront issues of privacy, confidentiality and ethics;
- Use current technology in laboratories;
- Attain real-world experience through cooperative education, internships, and/or other practicum activities; and
- Participate in student chapters of computing societies and organizations.

An active industry advisory committee is an important asset in helping faculty to incorporate current professional practices into the curriculum, as well as providing valuable contacts for students seeking employment. Faculty know that a conscious and proactive incorporation of professional practices into a curriculum in Information Systems benefits students in two ways: as a valuable component in a transfer-oriented information systems degree program, and in addressing industry needs for qualified personnel as students complete a career-oriented associate degree IS program.

Increasingly, the area of information systems has become critical to the operation of many organizations. Colleges should ensure that students are familiar with the nature of this field and the expectations of the workplace. Information systems employees must demonstrate professionalism and ethical behavior, adhere to codes of conduct, safeguard confidentiality, and respect privacy. They must take responsibility for their actions, be accountable to the organization, understand the impact of their work on others, and demonstrate effective and efficient work practices. This field also demands that professionals engage in an ongoing process of professional growth and development to ensure that their skills and abilities remain current with ever-changing technology. Any implementation of these guidelines must ensure that graduates can work within this framework.

2.6 Additional Program Components

In addition to the required and elective information systems courses, a college must design a degree program to fulfill other objectives as well. These include providing students with an appropriate level of mathematical knowledge and ability, familiarity with the scientific method of discovery and reasoning, effective written and oral communication skills, fluency with business processes and decision-making techniques, and the ability to work cooperatively and

effectively as team members. Any implementation of these guidelines, therefore, should include interdisciplinary courses, assignments, and projects that ensure all graduates can demonstrate fundamental and necessary skills. These include:

- Writing, speaking, listening, and presentation skills;
- Mathematical abilities;
- Critical analysis, problem-solving, and decision-making techniques;
- Familiarity with the social sciences, and arts and humanities; and
- Interpersonal skills and cultural tolerance.

Effective communication is critically important in every information systems career. Therefore, students must identify, develop, nurture, and use communication skills throughout an information systems degree program. All students must master effective abilities in writing, public speaking, and listening, and they must consistently demonstrate these skills in a variety of settings such as formal and informal, large group and one-on-one, technical and non-technical, and point and counterpoint.

An appropriate level of mathematical knowledge and ability is a required foundation for the study of the IS curriculum and pursuit of a career in this field. Programs following these guidelines should require students to complete a one-semester statistics course suitable for a business-oriented degree. Furthermore, students should master a one-semester course in discrete mathematics per the specifications in Appendix A.

It is important for information systems students to be aware of general business practices, including statistical techniques and business mathematics for accounting and finance. Information systems courses should incorporate an interdisciplinary and business-oriented approach to problem solving that is coordinated with course content offered by the business department. The business-related content of the IS program should also be influenced by interactions with the industry advisory committee.

Routine interaction on a global scale with individuals of diverse cultures and languages is a feature of today's rapidly changing world. This places even more emphasis on interpersonal and communication skills. Consequently, IS degree programs must prepare students to perform effectively in diverse environments by providing a social context for their overall education. Colleges can help provide this social context by hosting career days and colloquial sessions with various industry speakers.

Section 3

Body of Knowledge

3.1 Student Performance Objectives by Course

The student performance objectives that constitute the body of knowledge for associate-degree programs in information systems can be grouped into nine courses:

DMD:	Database Management and Design
IIS:	Introduction to Information Systems
NTT:	Networking and Telecommunications
PRG 1:	Programming Course 1
PRG 2:	Programming Course 2
SAR:	System Analysis and Requirements
SHS:	System Hardware and Software
UCA:	Using Computer Applications
WMS:	Web and Multimedia Information Systems

We define these courses not by topics, but by student performance objectives. Each objective relates to an identifier for the course. Appendix B provides details for the specific student performance objectives for each course. Note that a measurable performance objective describes each entry, which uses the appropriate verb to denote the intended depth of understanding. Appendix C, the Taxonomy of Learning Processes, provides a relative comparison for the depth of each objective.

For example, consider a course in Database Management and Design (DMD). Identifier DMD-03 indicates that a student must be able to "Describe relational and object-oriented database structures." From Appendix C, the word "Describe" relates to a "Comprehension" level of taxonomy. For identifier DMD-04, however, a student must be able to "Analyze conceptual, logical, and physical data modeling." The word "Analyze" relates to a "Higher-Order Thinking" level of taxonomy, which involves a greater depth of understanding.

As another example, consider a course in Web and Multimedia Information Systems (WMS). WMS-02 requires a student to explain the human-computer interaction factors that impact the design of a website. WMS-03 requires a student to create a website incorporating digital sound and video accessible to individuals with physical challenges. In the first case, the expectation is at an "understanding" level of taxonomy. In the second case, the expectation is at a "synthesis" level of taxonomy.

Faculty members should do their best to maintain the level of contrast and expectations as described by the student performance objectives when creating or modifying courses for their programs. This is important because it provides a way to include breadth and depth in courses.

It also is useful in the selection of course materials such as textbooks, laboratory manuals, and teacher's notes.

3.2 Curriculum Flowchart: Transfer Programs

Table 3.1 shows how a program might distribute the nine courses for a transfer-oriented Associate-Degree Information Systems core curriculum. By *transfer-oriented* we mean that the expectation of a graduating student is to transfer to a four-year program in information systems.

Table 3.1
Technical Curriculum for Transfer Programs

First Semester	*Second Semester*
IIS: Introduction to Information Systems	SHS: System Hardware and Software
	PRG 1: Programming Course 1
Third Semester	*Fourth Semester*
DMD: Database Management and Design -or- NTT: Networking and Telecommunications	WMS: Web and Multimedia Information Systems
PRG 2: Programming Course 2	NTT: Networking and Telecommunications -or- DMD: Database Management and Design

Note that Table 3.1 does not imply a complete curriculum. It only refers to the technical courses offered in the information systems component of the program. In addition, in the third and fourth semesters, students may have a choice of selection, may take both technical courses, or be restricted to a single course subject to the total objectives of the program and the college.

3.3 Implementation Issues: Transfer Programs

When implementing transfer programs in information systems, faculty and administrators should be aware of several factors. First, the student performance objectives in the Using Computer Applications (UCA) course are general prerequisite content for the entire IS program. Some students may be able to test out of this prerequisite course. Furthermore, conducting the Programming Course (PRG) objectives as a series of two programming courses allows students to experience more than one programming language and/or more than one programming paradigm. Additionally, students may be able to achieve the Web and Multimedia Information Systems (WMS) objectives either with a database or with a network prerequisite, depending on the content emphasis of the WMS course. Table 3.2 shows possible prerequisite relationships among the different courses. Each institution should adapt its own prerequisite structure based upon its mission and the objectives of the program. Depending on the structure of an institution's academic departments, departments could share some of these courses. For example, an Information Systems department and a Computer Science department could share courses in programming, database, and networking.

Table 3.2
Prerequisite Relationships - Transfer

All	have a pre-requisite of	IIS and UCA
PRG 2	Has a pre-requisite of	PRG 1
NTT	Has a pre-requisite of	SHS
DMD	Has a pre-requisite of	SHS
WMS	Has a pre-requisite of	DMD or NTT, and PRG 2

3.4 Curriculum Flowchart: Career-Oriented Programs

Table 3.3 shows how a program might distribute technical courses for a career-oriented Associate-Degree Information Systems core curriculum. By *career-oriented* we mean that the expectation of a graduating student is to enter the job market in an information systems position. Note that in contrast to transfer programs, Table 3.3 shows a concentration of information systems courses.

Table 3.3
Technical Curriculum for Career-oriented Programs

First Semester	*Second Semester*
IIS: Introduction to Information Systems	PRG 1: Programming Course 1
UCA: Using Computer Applications	NTT: Networking and Telecommunications
SHS: System Hardware and Software	
Summer	
Internship	
Third Semester	*Fourth Semester*
DMD: Database Management and Design	WMS: Web and Multimedia Information Systems
PRG 2: Programming Course 2	SAR: Systems Analysis and Requirements
	Capstone Project Course

3.5 Implementation Issues: Career-Oriented Programs

When implementing career-oriented programs in information systems, faculty and administrators should be aware of several issues. First, the goal is to teach the UCA student performance objectives in depth for this program and augment them with an associated programming language. Students should complete the internship experience before starting the SAR objectives. Additionally, faculty members should teach the PRG objectives as a series of two

programming courses in which more than one language is used. The WMS objectives can take place with either a database or network prerequisite, depending on the emphasis of the course. Additionally, the Capstone Project course should enhance local employability skills. Some institutions may elect to expand these student performance objectives into multiple series of course sequences (and/or tracks) to emphasize further hands-on practical experience and skill building; this option may require more than the suggested number of ten courses. Table 3.4 shows the suggested prerequisite structure for such career-oriented courses. Depending on the structure of an institution's academic departments, departments could share some of these courses. For example, an Information Systems department and a Computer Science department could share courses in programming, database, and networking.

Table 3.4
Prerequisite Relationships - Career

PRG 1	Has a pre-requisite of	IIS and UCA
NTT	Has a pre-requisite of	IIS and UCA and SHS
PRG 2	Has a pre-requisite of	PRG 1
DMD	Has a pre-requisite of	IIS and UCA and SHS
WMS	Has a pre-requisite of	DMD and NTT and PRG 2
SAR	Has a pre-requisite of	DMD and NTT and PRG 2

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Appendix A

Description of Discrete Mathematics Course

Discrete Mathematics

This course introduces the foundations of discrete mathematics as they apply to computing. Topics include functions, relations, sets, simple proof techniques, Boolean algebra, propositional logic, predicate logic, digital logic, elementary number theory, and the fundamentals of counting.

Prerequisite: College Algebra.

Syllabus:

- Fundamental structures: functions (surjections, injections, inverses, composition); relations (reflexivity, symmetry, transitivity, equivalence relations); sets (Venn diagrams, complements, Cartesian products, power sets); pigeonhole principle; cardinality and countability
- Boolean algebra: Boolean values; standard operations on Boolean values; de Morgan's laws
- Propositional logic: logical connectives; truth tables; normal forms (conjunctive and disjunctive); validity
- Predicate logic: universal and existential quantification; modus ponens and modus tollens; limitations of predicate logic.
- Digital logic: logic gates, flip-flops, counters; circuit minimization.
- Descriptive statistics: methods of collecting data, frequency distribution graphs, measures of central tendency, variation, and position, and use of z-scores.
- Basics of counting: counting arguments; pigeonhole principle; permutations and combinations; binomial coefficients.

Appendix B

Courses, Identifiers, and Student Performance Objectives

The table below details the specific student performance objectives for each course. Note that each entry is described as a measurable performance objective and uses the appropriate verb to denote the intended depth of understanding (see Appendix C: Taxonomy of Learning Processes).

Course	*Identifier*	*Student Performance Objective*
DMD	DMD-01	Explain basic database terminology and concepts, including data dictionaries.
DMD	DMD-02	Produce a simple database design.
DMD	DMD-03	Describe relational and object-oriented database structures.
DMD	DMD-04	Analyze conceptual, logical, and physical data modeling.
DMD	DMD-05	Describe types of data classifications and data protection mechanisms.
DMD	DMD-06	Describe structured and object design approaches.
DMD	DMD-07	Describe access control techniques (including DAC and MAC).
DMD	DMD-08	Apply design tools to database development.
DMD	DMD-09	Apply modeling tools to database development.
DMD	DMD-10	Plan project and identify functional specifications (in a simulated environment).
DMD	DMD-11	Develop database applications (in a simulated environment).
DMD	DMD-12	Convert current data (in a simulated environment).
DMD	DMD-13	Implement database applications using standard query languages, user interfaces, and reports (in a simulated environment).
DMD	DMD-14	Conduct post-implementation review of database application (in a simulated environment).
DMD	DMD-15	Explain data repositories, data warehousing, and data mining.
IIS	IIS-01	Discuss the history of computing.
IIS	IIS-02	Summarize the components of an information system.
IIS	IIS-03	Define distributed computing and the role of information technologies in the organization; summarize knowledge work productivity software and techniques used in information systems.
IIS	IIS-04	Describe the organization and management of IS departments; summarize careers related to information systems.
IIS	IIS-05	Summarize and give examples of information systems policies and standards.
IIS	IIS-06	Discuss licensing and certification of computing professionals; describe the role of lifelong learning in information systems careers.
IIS	IIS-07	Identify various workplace arrangements (mobile workers, home-office workers, remote workers) for knowledge workers and describe the associated enabling technologies; compare the advantages and disadvantages of outsourcing.

Course	Identifier	Student Performance Objective
IIS	IIS-08	Identify the characteristics of an effective IS professional (e.g., works collaboratively in teams, communicates well, and manages time and projects effectively); describe the attributes of the IS professional code of ethics and the role of professional associations in information systems.
IIS	IIS-09	Summarize liability issues associated with hardware and software systems; summarize legal ramifications and social consequences associated with software development.
IIS	IIS-10	Discuss IS security management concepts and principles: privacy, confidentiality, integrity, availability, identification and authentication.
IIS	IIS-11	Discuss software ownership and licensing; describe methods of software copy protection and encryption.
IIS	IIS-12	Identify issues associated with the protection of data storage and data transmission.
IIS	IIS-13	List the characteristics of various information systems, such as artificial intelligence, expert systems, transaction processing, decision support systems, e-commerce, web, and GIS.
IIS	IIS-14	Summarize the process of IS specification, development, deployment, evaluation, and management.
IIS	IIS-15	Demonstrate proficiency with online documentation and help files.
IIS	IIS-16	Evaluate the management and use of emerging technologies and personal productivity tools.
NTT	NTT-01	Describe the characteristics of the client-server network environment and its different variations.
NTT	NTT-02	Diagram and explain the layered architectures of the OSI and TCP/IP models.
NTT	NTT-03	Define data communications and telecommunications concepts and functions.
NTT	NTT-04	Describe the functions of various telecommunications devices and systems.
NTT	NTT-05	Describe networking topologies; identify appropriate topologies for given scenarios.
NTT	NTT-06	Identify and describe data telecommunication protocols for wired and wireless networks.
NTT	NTT-07	Compare and contrast digital telecommunications transmission media and their characteristics.
NTT	NTT-08	Explain the features and capabilities of converged voice-video-data networks.
NTT	NTT-09	Analyze the role of hardware and software components, systems, and organizational policy in addressing network reliability and security.
NTT	NTT-10	Describe network security concepts such as firewalls, access control systems (RADIUS, VPN), and intrusion detection systems.
NTT	NTT-11	Create a local-area network installation and configuration.
NTT	NTT-12	Apply hardware and software network administration tools.
PRG 1	PRG-01	Discuss the history of programming languages.
PRG 1	PRG-02	Apply algorithm design and development techniques.
PRG 1	PRG-03	Apply sequence, selection, and iteration control structures to program development.
PRG 1	PRG-04	Construct executable and reusable program modules.
PRG 1	PRG-05	Apply various programming paradigms, such as event-driven and object-oriented.
PRG 1	PRG-06	Construct program code using problem-solving techniques and tools.
PRG 1	PRG-07	Create specifications for testing and debugging.
PRG 1	PRG-08	Apply standard debugging tools to problem solutions.
PRG 1	PRG-09	Construct program solutions using various data forms and basic data structures (introductory level).

Course	Identifier	Student Performance Objective
PRG 1	PRG-10	Produce technical documentation (introductory level).
PRG 2	PRG-11	Construct program solutions using various data forms and basic data structures (advanced level).
PRG 2	PRG-12	Produce technical documentation (advanced level).
PRG 2	PRG-13	Explain the use of pre- and post-conditions to verify and validate programs.
PRG 2	PRG-14	Describe the nature of error conditions; construct program code using error and exception handling techniques.
PRG 2	PRG-15	Describe security considerations associated with program code and execution (including encryption techniques and malicious codes such as worms, viruses, logic bombs, Trojan horses, trap doors).
PRG 2	PRG-16	Summarize various language translation methods.
PRG 2	PRG-17	Define abstract data types as objects.
SAR	SAR-01	Discuss the nature of formal system specifications (including security issues).
SAR	SAR-02	Describe the nature of design and implementation teams, interpersonal relations and consensus-building, and synergistic solutions.
SAR	SAR-03	Summarize analysis and design documents such as feasibility studies, cost/benefit analyses, RFPs (Request for Proposal), and RFQs (Request for Quotation).
SAR	SAR-04	Discuss software maintenance activities and management of programming revisions for the continuous improvement of information systems.
SAR	SAR-05	Discuss liability issues in creating software systems for in-house and commercial implementations.
SAR	SAR-06	Identify software validation and testing techniques in the context of software quality metrics.
SAR	SAR-07	Discuss risk assessment and feasibility considerations.
SAR	SAR-08	Describe techniques for software audits and reviews.
SAR	SAR-09	Identify the factors used to assess the effectiveness of a solution, including system specifications, user requirements, security considerations, and performance management.
SAR	SAR-10	Compare the roles of test environments versus production environments.
SAR	SAR-11	Discuss the importance of end-user training.
SAR	SAR-12	Demonstrate proficiency with project planning tools such as work breakdown structure, Gantt or bar charts, and critical path methods.
SAR	SAR-13	Summarize the complete information system life cycle phases.
SAR	SAR-14	Identify end-user requirements for the development of an application (in a simulated environment).
SAR	SAR-15	Apply visual design tools to system requirements, specification and design (in a simulated environment).
SAR	SAR-16	Construct a prototype solution for end-user review (in a simulated environment).
SAR	SAR-17	Analyze the prototype solution for performance and scalability (in a simulated environment).
SAR	SAR-18	Construct and implement a final application, including documentation and end-user training guidelines (in a simulated environment).
SAR	SAR-19	Summarize techniques for effective project planning and management (including conversion projects).
SHS	SHS-01	Describe basic computer hardware organization; the operations of computer components (including bus and memory) in the context of the instruction fetch and execute cycle; and how I/O modules interact with the rest of the computer system.
SHS	SHS-02	Describe the concept of a trusted computing base and security kernel.
SHS	SHS-03	Summarize the history of computers from an architectural perspective; explain the concepts of the von Neumann architecture; compare contemporary architectures.

Course	Identifier	Student Performance Objective
SHS	SHS-04	Describe the relationship between different base numbering systems and conversion techniques; describe different data formats such as numeric, alphanumeric, sound, and image.
SHS	SHS-05	Describe basic computer software, including operating system software (interoperability, standalone, network, and multi-user) and application software.
SHS	SHS-06	Perform installation and configuration of system hardware and components.
SHS	SHS-07	Perform installation and configuration of operating system and application software.
SHS	SHS-08	Evaluate troubleshooting strategies and techniques.
SHS	SHS-09	Demonstrate proficiency with a variety of troubleshooting methods and diagnostic tools.
SHS	SHS-10	Produce simple system specification documents.
SHS	SHS-11	Describe techniques of hardware and software security.
UCA	UCA-01	Demonstrate proficiency in the use of office productivity knowledge work software (word processing, spreadsheet, database, email, web browser, and presentation software).
UCA	UCA-02	Apply personal information management tools and groupware concepts to routine business applications.
UCA	UCA-03	Integrate multiple office productivity software tools into a comprehensive solution to a typical workplace scenario.
UCA	UCA-04	Create web pages using HTML.
UCA	UCA-05	Conduct web-based research; demonstrate proficiency with online documentation and help files.
WMS	WMS-01	Create web pages using HTML, XML, page editors, and tools.
WMS	WMS-02	Explain the human-computer interaction factors that impact the design of a website.
WMS	WMS-03	Create a website incorporating digital sound and video accessible to individuals with physical challenges.
WMS	WMS-04	Describe security assurance techniques (including PKI).
WMS	WMS-05	Design a secure and interactive website.
WMS	WMS-06	Create a database driven website.
WMS	WMS-07	Create a secure e-commerce web-based application.
WMS	WMS-08	Demonstrate proficiency in using and interpreting website management tools.
WMS	WMS-09	Create a website for web services that incorporates server side programming.

Appendix C

Taxonomy of Learning Processes

Table B.1 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.

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 – build
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 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 - move - show

The ACM Two-Year College Education Committee

Committee Charter:
The Two-Year College Education Committee is a standing committee (since October, 1991) of the ACM Education Board. 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.

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