

Information Technology Competency Model of Core Learning Outcomes and Assessment for Associate-Degree Curriculum

October 14, 2014

The Association for Computing Machinery Committee
for **Computing Education in Community Colleges**
(ACM CCECC)



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October 14, 2014

Produced by the
ACM Committee for Computing Education in Community Colleges (CCECC)

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Association for
Computing Machinery

Advancing Computing as a Science & Profession

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Advancing Computing as a Science & Profession

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Introduction

Charter and Background

The ACM Committee for Computing Education in Community Colleges (CCECC), at the direction of the ACM Education Board, convened a task force to produce curricular guidance for associate-degree programs in Information Technology. In fulfilling its charge (Appendix A), the CCECC identified the body of knowledge as a set of fifty student learning outcomes that constitute core Information Technology (IT) competencies for all IT-related associate-degree programs. These learning outcomes were created with the intent of being adaptable, not overly technology specific, and to remain current for the foreseeable future. Furthermore, these core IT learning outcomes were primarily influenced by:

- ✓ current and future needs of business and industry,
- ✓ professional and industry certifications,
- ✓ government and standards bodies, and
- ✓ related-IT curricula, including the ACM/IEEE-CS *Curriculum Guidelines for Undergraduate Degree program in Information Technology*, and the U.S. Department of Labor *Information Technology Competency Model*.

The fifty student learning outcomes span the first three levels of Bloom's Revised Taxonomy (Appendix C), and each outcome is accompanied by a three-tier assessment rubric that provides additional clarity and a measureable evaluation metric. In Appendix E, these core IT learning outcomes are correlated to existing courses in degree and certificate programs at several community and technical colleges nationwide. The growing collection of correlations from other colleges is viewable online at www.capspace.org/ITcorrelations/.

This report represents a significant evolution in curricular guidance, but also stands on the shoulders of and builds upon two previous IT-related curricular reports produced by this committee through the decades: 1) *Guidelines for Associate-Degree Programs to Support Computing in a Networked Environment* (Klee, Austing, Campbell, Cover, & Currie Little, 2000), and 2) *Computing Curricula Guidelines for Associate Degree Programs* (Klee, Austing, Impagliazzo, Currie Little, & Chlopan, 1993).

The Sub-Disciplines of Computing

ACM currently categorizes the overarching discipline of computing into five defined sub-disciplines (ACM, 2005) : computer science, computer engineering, software engineering, information systems and information technology. This report specifically focuses on information technology defined by the ACM CCECC as follows:

Information Technology involves the design, implementation and maintenance of technology solutions and support for users of such systems. Associated curricula focus on crafting hardware and software solutions as applied to networks, security, client-server and mobile computing, web applications, multimedia resources, communications systems, and the planning and management of the technology lifecycle (ACM CCECC, 2009).

ACM/IEEE-CS 2008 Curriculum Guidelines for Undergraduate Degree Programs in Information Technology

ACM and its partner professional societies have jointly produced significant volumes of curricular recommendations and guidelines for baccalaureate computing programs, known collectively as the ACM Computing Curricula series (ACM, 2014). Among these is the publication *IT 2008: Curriculum Guidelines for Undergraduate Degree Programs in Information Technology* (ACM & IEEE-CS, 2008). This work was one of many sources that influenced the curricular guidance outlined in this report.

U.S. Department of Labor Information Technology Competency Model

At the direction of the United States Department of Labor, the Employment & Training Administration has produced a comprehensive competency model for the Information Technology industry. The *Information Technology Competency Model* identifies the knowledge, skills, and abilities deemed necessary for workers to perform successfully in the field of IT. This work was one of many sources that provided a foundation for the curricular guidance outlined in this report (U.S. Department of Labor, 2012).

Learning Outcomes

The ACM CCECC used a customized version of Bloom’s Revised Taxonomy (Appendix C) in formulating student learning outcomes. For each level, a well-defined collection of measurable action verbs is specified. The active learning verbs chosen for the core IT competencies were selected from the first three levels of Bloom’s Taxonomy: “remembering”, “understanding”, and “applying.” These are frequently augmented by higher Bloom’s levels in the “highly developed” column of the associated assessment rubric. The distribution of core IT competencies by Bloom’s level appears in Figure 1. Depending upon the way one organizes the learning outcomes into an associate-degree or certificate program, higher Bloom’s levels can be included to meet local needs as appropriate to the specific IT program.

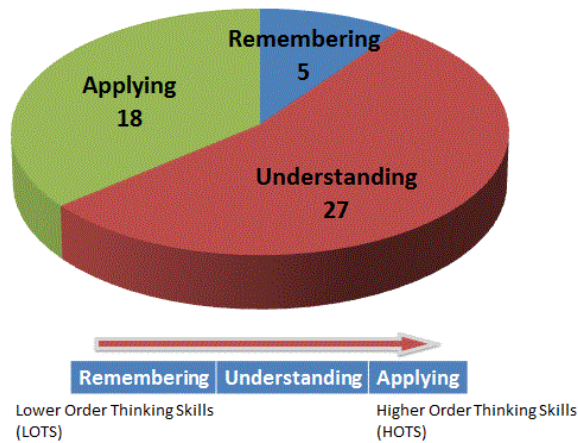


Figure 1: ACM Core IT Learning Outcomes Distribution across Bloom's Levels

For an interactive mapping of the core IT competencies to Bloom’s Revised Taxonomy visit www.capspace.org/ITmappings/ and select the Bloom’s Taxonomy option from the dropdown menu.

Assessment of Learning Outcomes

In formulating assessment rubrics, The ACM CCECC uses a structured template comprised of three tiers: “emerging”, “developed”, and “highly developed.” Typically as the level of student achievement progresses from “emerging” to “highly developed”, the level of Bloom’s verbs also increases from the lower order thinking skills (LOTS) to the higher order thinking skills (HOTS), including “analyzing” and “evaluating.”

The cognitive outcomes associated with the core IT competencies reflect technical domains, including client computing and user support, databases and information management, digital media and immersive technology, networking and convergence, programming and application development, servers, storage and virtualization, and security and information assurance. The targeted knowledge in these domains comprises the majority of the learning outcomes in this report. Student competencies constituting affective outcomes typically assess student demonstration of workplace soft skills, such as professional behavior and business awareness, ethical conduct, and the social awareness of the impact of technology. Given the ubiquity of computing technologies across a global society, ethical behavior and adherence to codes of conduct for computing professionals is imperative; therefore, careful consideration of legal, ethical, and societal issues involving computing, the Internet, databases, property rights and privacy concerns are essential to the education of computing professionals. These highly sought-after behaviors and attitudes are also included as part of the learning outcomes in this report.

Business Context

Strongly influenced and championed by several IT industry task force members and fashioned with direct input from business leaders, the core IT competencies are reflective of the foundational knowledge and technical skills desired by employers. In addition to ensuring IT competencies are associated with enterprise scenarios reflective of business mission and goals, learning outcomes also include workplace and personal effectiveness competencies, such as business awareness, communication skills, collaboration and teamwork, and ethics and professional behaviors. With the persistent global demand for computing professionals and the realized benefits of a diverse workforce, the core IT learning outcomes include an awareness of future workforce and technology trends, such as broadening participation in computing and reviewing emerging technologies, and their related impact on the future of computing.

IT as a Service Discipline

The ACM CCECC has long recognized the “computing for other disciplines” notion, first codified for associate-degree programs in its 1993 multi-volume curriculum report – Computer Support Services, Computing and Engineering Technology, Computing for Information Processing,

Computing Sciences, and Computing for Other Disciplines (COD). As stated in the COD volume, “Throughout the evolution of computing education, no organization supported a report with recommendations specifically addressing courses for other disciplines. The present report is the first to make such recommendations” (Klee, Austing, Impagliazzo, Currie Little, & Chlopan, 1993). Two decades later information technology has become interdisciplinary and is an integral part of every field of study and every profession. The idea of “IT as a service discipline” is as equally important as other disciplines that provide students with skillsets (e.g., statistical analysis or scientific method). The collection of core IT competencies contained in this current guidance provides a relevant example with the inclusion of learning outcomes related to digital media, where the distinctions between the tools themselves (IT artifacts), the use of the tools (IT skills) and the application of the tools (artworks) may challenge computing educators in the design of effective curriculum and assessment methods. Such is the extraordinary, interdisciplinary nature of the field of IT.

International Sphere of Applicability

The curricular resources made available by the ACM CCECC through CAPspace.org provide meaningful guidance for two-year post-secondary higher education programs in a wide variety of settings. This is achieved in large measure by defining specific curricular content in terms of measurable student learning outcomes accompanied by detailed rubrics for effective assessment of student learning. While some specific implementation aspects of these resources may be more prominent in the United States, the resources appear in a manner that makes them readily applicable to numerous settings and easily adaptable to a wide variety of implementation strategies worldwide.

In the United States, the American Association of Community Colleges (AACC) reports that approximately one-half of all undergraduate college students are enrolled in community colleges, typically pursuing a two-year program of study leading to a recognized associate degree (AACC, 2013). The IT curricular guidance contained herein is applicable to such degree programs.

Beyond the United States, many countries have post-secondary higher education options featuring similar programs of study. The AACC underscores this via its Office of International

Programs and Services whose partnership initiatives between U.S. community colleges and similar institutions around the world “support the exchange of best practices, enhance mutual understanding between cultures, and expand opportunities for students to gain global competence and skills for the 21st Century” (AACC, 2013).

As presented in a reflective interview by McJunkin entitled "The Global Linkage," James McKenney, AACC Vice-President for Economic Development and International Programs, spoke as early as 2002 about the rapidly expanding phenomenon of community colleges, two-year technical colleges, and the two-year structure in general throughout Europe, the Americas and Asia (McJunkin, 2009).

Mathematics Proficiency

The core IT learning outcomes require that students have prerequisite mathematical proficiency equivalent to intermediate algebra. Higher level courses, such as college algebra and statistics may be necessary for specific IT programs.

Affiliated Coursework

Routinely, programs of study in technical fields include affiliated coursework designed to provide foundational knowledge in disciplines either prerequisite to or synergistic with the primary pursuit. In the case of Information Technology, such coursework includes mathematics and quantitative reasoning as well as written and spoken communication. Additionally, given the wealth of settings for IT careers – affiliated coursework may also include topics as far-ranging as organizational behavior and foundations of business, physics and engineering, humanities and the arts, cultural studies and world languages, and social and behavioral sciences.

How to Use this Competency-based Curricular Guidance

Competency-based Learning and Competency Models

Competency -based learning also known as outcomes -based learning is different from the traditional education approach. Instead of focusing on how much time students spend learning a particular topic or concept (Carnegie unit credit hour), the outcomes-based model assesses whether students have mastered the given competencies, namely the skills, abilities, and knowledge. Simply stated, outcomes-based learning is not about seat time, but rather about what students know and what they are able to do (University of Wisconsin System, 2014).

In 2012 the U.S. Department of Labor published its *Information Technology Competency Model* (U.S. Department of Labor, 2012), and in 2013 the Software Engineering Institute published the *Software Assurance Competency Model* (Hilburn, Ardis, Johnson, Kornecki, & Mead, 2013). The U.S. Department of Education endorsed competency-based programs in March 2013, and Arne Duncan, U.S. Secretary of Education wrote: “We know many students and adult learners across the country need the flexibility to fit their education into their lives or work through a class on their own pace, and these competency-based programs offer those features – and they are often accessible to students anytime, anywhere” (Ed.gov, 2013).

Consequently, the contemporary model for constructing curricula in community colleges is an approach based upon clearly-defined and measureable learning outcomes rather than collections of topics. Community and technical colleges typically rely on assessment experts working hand-in-hand with faculty to integrate sound evaluation metrics at both the course and program levels. Consistent with this practice and the ACM Education Board’s charge (see Appendix A), the CCECC focused on learning outcomes rather than a list of topics in order to promote greater adaptability across institutions and provide much-needed guidance for assessment. A given learning outcome may be addressed in one or more technical domains within an IT program, and a given associate-degree or certificate program may organize and use the outcomes in a manner best suited to their local needs. Topics and instructional methods remain the purview of individual institutions and their local advisory boards.

The core IT learning outcomes are itemized in the Body of Knowledge (chapter III) and can also be viewed interactively in a variety of formats to facilitate their use for diverse purposes at www.capspace.org/IT/. Such uses of the student learning outcomes and their associated assessment rubrics, correlations and mappings include, but are not limited to the following.

Conducting program reviews to update and create curriculum

For example, the core IT learning outcomes can be used by colleges to conduct periodic program reviews with the intent of validating their existing IT courses, certificates, and degrees, as well as to create new IT curriculum. The growing collection of exemplars correlated to the core IT learning outcomes makes it easy for colleges to compare and develop new courses, certificates and degree programs in information technology. Actual course and program correlations from across the nation are listed in Appendix E and online at www.capspace.org/ITcorrelations/.

Creating program outcomes

For example, 100% of the ACM CCECC learning outcomes for core IT competencies map to the IT Knowledge Units on which the *Curriculum Guidelines for Undergraduate Degree Programs in Information Technology* (ACM & IEEE-CS, 2008) were constructed. To view the mapping for the IT Knowledge Units, see www.capspace.org/ITmappings/.

Facilitating program and course articulation

For example, the “C-ID Information Systems Faculty Discipline Review Group” in California is using these guidelines to establish a model curriculum for two-year IT programs with the expectation of enhancing it to a transfer model curriculum. Another articulation example is manifested in high schools that adhere to the Computer Science Teachers Association (CSTA) standards. To view the mapping for the CSTA standards, see www.capspace.org/ITmappings/.

Establishing authoritative source for program and institutional accreditation

For example, the IT competencies defined by the ACM CCECC have been mapped to the Accreditation Board for Engineering and Technology (ABET) criteria for Information Technology. To view the ABET mapping, see www.capspace.org/ITmappings/.

Mapping to industry academies and certifications

For example, institutions currently offering curricula leading to vendor certification from companies such as Microsoft, EMC, Juniper Networks, NetApp, Oracle, Cisco, and CompTIA will see that the IT core competencies are reinforced across those curriculum frameworks.

Complying with government-sponsored frameworks

For example, mappings have been established between the IT competencies and the U.S. Department of Labor *Information Technology Competency Model* championed by Mid-Pacific Information and Communication Technologies Center (MPICT), Broadening Advanced Technological Education Connections (BATEC), and the National Convergence Technologies Center (CTC). To view the mapping for the IT Competency Model, see www.capspace.org/ITmappings/.

Interacting with local advisory boards

For example, an advisory board at Bluegrass Community and Technical College (BCTC) reviewed the IT core competencies and compared them to learning outcomes for BCTC's existing two-year computing curricula and provided feedback to strengthen the local Computer & Information Technologies program of study.

Crafting course and program assessments

Since this curricular guidance was developed with assessment in mind from the beginning, learning outcomes and evaluation metrics were identified prior to and in lieu of prescribed courses. As such, this guidance ideally facilitates the creation of a wide range of competency-based evaluations, such as course/program projects and portfolios as well as corresponding rubrics.

Designing placement and challenge testing

For example, correlating the courses in a curriculum, with the aid of the assessment rubric for evaluation, readily accommodates the creation of placement tests and challenge exams.

CAP Space – Curriculum, Assessment and Pedagogy

In 2009, CAP Space.org (Figure 2) was established by the ACM CCECC as an interactive repository of educational resources for associate-degree programs in computing. Today, the curricular, assessment, and pedagogical resources of CAP Space support educators in the computer science, software engineering, computer engineering, and information technology disciplines. Resources developed specifically for information technology include the following:

- ✓ The full IT report – www.capspace.org/ITreport/
- ✓ The ACM core IT learning outcomes - www.capspace.org/IT/
- ✓ The associated assessment rubric - www.capspace.org/ITassessment/
- ✓ The growing collection of correlation exemplars - www.capspace.org/ITcorrelations/
- ✓ The online form and instructions for submitting correlations – www.capspace.org/correlation/
- ✓ The ACM core IT learning outcomes mapped to other curricula, classifications, and frameworks - www.capspace.org/ITmappings/
- ✓ The active learning verbs of Bloom’s Revised Taxonomy - www.capspace.org/BloomsTaxonomy/



Figure 2: CAPSpace.org

Body of Knowledge
www.capspace.org/IT/

The fifty learning outcomes represent core competencies that a student in any IT-related program must demonstrate. The learning outcomes should thus be seen as foundational/core for any associate-degree IT program, and not as specifying a complete program. Curricula for specific IT programs (e.g., networking, programming, digital media, and user support) will necessarily include additional coursework in one or more defined areas of study.

The core IT learning outcomes are grouped into technical competency areas and workplace skills.

See Table 1.

Technical Competency Areas

- ✓ An ability to demonstrate core IT competency in client computing and user support.
- ✓ An ability to demonstrate core IT competency in database and information management.
- ✓ An ability to demonstrate core IT competency in digital media and immersive technology.
- ✓ An ability to demonstrate core IT competency in networking and convergence.
- ✓ An ability to demonstrate core IT competency in programming and application development.
- ✓ An ability to demonstrate core IT competency in servers, storage and virtualization.

Workplace Skills

- ✓ An ability to function effectively as a member of a diverse team to accomplish common goals.
- ✓ An ability to read and interpret technical information, as well as listen effectively to, communicate orally with, and write clearly for a wide range of audiences.
- ✓ An ability to engage in continuous learning, as well as research and assess new ideas and information to provide the capabilities for lifelong learning.
- ✓ An ability to exhibit professional, legal, and ethical behavior.
- ✓ An ability to demonstrate business awareness and workplace effectiveness.

Table 1: ACM Core IT Learning Outcomes

An ability to demonstrate core IT competency in client computing and user support	
1	Carry out trouble-shooting strategies for resolving an identified end-user IT problem.
2	Differentiate among various operating systems.
3	Explain the process of authentication and authorization between end-user devices and computing network resources.
4	Identify a variety of assistive or adaptive technologies and universal design considerations.
5	Identify basic components of an end-user IT system.
6	Implement a hardware and software configuration responsive to an identified scenario.
7	Summarize life-cycle strategies for replacement, reuse, recycling IT technology and resources.
8	Summarize strategies to support or train users with their IT resources.
9	Use a variety of practices for making end-user IT systems secure.
An ability to demonstrate core IT competency in database and information management	
10	Describe the data management activities associated with the data lifecycle.
11	Diagram a database design based on an identified scenario.
12	Differentiate between public and private data.
13	Discuss applications of data analytics.
14	Discuss issues relevant to dealing with very large data sets, both structured and unstructured.
15	Identify database administration tasks.
16	Produce simple database queries.
17	Use data analytics to support decision making for a given scenario.
An ability to demonstrate core IT competency in digital media and immersive technology	
18	Differentiate among a variety of technology-based sensory interactions.
19	Differentiate among data types, data transfer protocols and file characteristics specific to the targeted use.
20	Illustrate the activities of a digital media design process.
21	Implement communication principles into digital media design.
An ability to demonstrate core IT competency in networking and convergence	
22	Carry out basic computer network troubleshooting techniques.
23	Describe the layers, protocols and components of the OSI model.
24	Diagram the components of an integrated IT system.
25	Differentiate among various computer networking models.
26	Differentiate among various techniques for making a computer network secure.
27	Summarize the flow of data through a computer network scenario.
An ability to demonstrate core IT competency in programming and application development	
28	Demonstrate best practices for designing end-user computing interfaces.
29	Demonstrate the techniques of defensive programming and secure coding.
30	Diagram the phases of the Secure Software Development Lifecycle.
31	Discuss software development methodologies.
32	Summarize the differences among various programming languages.
33	Use a programming or a scripting language to share data across an integrated IT system.
34	Use a programming or a scripting language to solve a problem.

An ability to demonstrate core IT competency in servers, storage and virtualization	
35	Differentiate among strategies for business continuity provisioning of IT resources at the enterprise level.
36	Discuss data governance and its implications for users as well as IT professionals.
37	Identify a variety of enterprise-level digital storage technologies.
38	Implement an application of virtualization.
39	Modify a system to improve data confidentiality or regulatory compliance.
40	Summarize the implications of various cloud computing models.
41	Summarize the security implications and risks for distributed IT systems.
An ability to function effectively as a member of a diverse team to accomplish common goals	
42	Use communication, negotiation, and collaboration skills as a member of a diverse team.
An ability to read and interpret technical information, as well as listen effectively to, communicate orally with, and write clearly for a wide range of audiences	
43	Describe the attitudes, knowledge and abilities associated with quality customer service.
44	Produce technical documentation responsive to an identified computing scenario.
45	Use documentation or a knowledge base to resolve a technical challenge in an identified computing scenario
An ability to engage in continuous learning as well as research and assess new ideas and information to provide the capabilities for lifelong learning	
46	Discuss significant trends and emerging technologies and their impact on our global society.
An ability to exhibit professional, legal, and ethical behavior	
47	Demonstrate professional behavior in response to an ethically-challenging scenario in computing.
48	Summarize the tenets of ethics and professional behavior promoted by international computing societies.
An ability to demonstrate business awareness and workplace effectiveness	
49	Describe IT procurement processes for goods and services.
50	Summarize the role of IT in supporting the mission and goals of an organization.

Assessment Metrics

For years, rubrics have been used in higher education as assessment instruments to gauge student learning. In 2013, 84% of colleges and universities in the U.S. had adopted clearly defined learning outcomes for undergraduates, and rubrics were among the most commonly used assessment metrics (Kuh, 2014). The typical rubric is comprised of three main components: (1) criteria (2) levels of performance, and (3) descriptors. Furthermore, there are two classifications of assessment rubrics used today: holistic and analytic. Holistic rubrics provide a single evaluation of the overall quality of student work/learning irrespective of the number of criteria. Conversely, analytic rubrics provide an evaluation for each criterion in the rubric and thus afford detailed feedback on the mastery of each standard in the rubric (DePaul Teaching Commons).

ACM Core IT Learning Outcomes with Three-Tiered Assessment

The core IT competencies are expressed in fifty student learning outcomes. Each learning outcome has an associated three-tiered assessment rubric which provides further clarity and a meaningful evaluation of the outcome. Table 2 is an analytic rubric facilitating assessment for each of the fifty IT core learning outcomes based upon three levels of performance:

“emerging”, “developed”, and “highly developed.” The body of Table 2 contains descriptors of **sample** student achievement for each performance level and each learning outcome. This detailed analytic rubric is included to assist those who are creating or reviewing associate IT degrees by providing recommended core IT learning outcomes and **sample** assessment metrics.

The entire list of the core IT learning outcomes with the associated assessment rubric is available online in an interactive format at www.capspace.org/ITassessment/.

Table 2: ACM Core IT Learning Outcomes with Three-tiered Assessment

<i>An ability to demonstrate core IT competency in client computing and user support</i>				
	Learning Outcome	Emerging	Developed	Highly Developed
1	Carry out trouble-shooting strategies for resolving an identified end-user IT problem.	Lists appropriate methods or techniques to identify and resolve end-user IT problems.	Investigates a given problem using appropriate methods or techniques, including communication and technical strategies.	Analyzes an end-user IT problem to successful resolution.
2	Differentiate among various operating systems.	Describes a few commonly used operating systems.	Summarizes several operating systems and differentiates among those systems.	Compares several operating systems on the basis of computing platforms and usability.
3	Explain the process of authentication and authorization between end-user devices and computing network resources.	Identifies the processes of authentication and authorization across network resources.	Summarizes the processes of user authentication and authorization across networks resources.	Compares several implementations of user authentication and authorization across network resources.

4	Identify a variety of assistive or adaptive technologies and universal design considerations.	Lists a few assistive or adaptive technologies and universal design considerations.	Describes a variety of assistive or adaptive technologies and universal design considerations.	Discusses universal design and accessibility principles, and classifies assistive or adaptive technologies appropriate to their applications.
5	Identify basic components of an end-user IT system.	Lists some but not all components of an end-user IT system or incorrectly lists those components.	Describes the basic components of an end-user IT system.	Diagrams the basic components of an end-user IT system.
6	Implement a hardware and software configuration responsive to an identified scenario.	Identifies hardware and software components for a given scenario.	Implements an appropriate hardware and software configuration for a given scenario, such as configuring assistive technology on a desktop for an ADA accommodation.	Compares several hardware and software configurations for a given scenario and recommends the best solution.
7	Summarize life-cycle strategies for replacement, reuse, recycling IT technology and resources.	Lists a few strategies for replacing, reusing, and recycling IT resources.	Summarizes principles of sustainable computing and lifecycle strategies for replacing, reusing, and recycling IT resources.	Outlines a sustainable computing and IT lifecycle plan for a given scenario.
8	Summarize strategies to support or train users with their IT resources.	Lists a few strategies for supporting or training end-users and their IT resources.	Summarizes strategies and best practices for supporting or training end-users and their IT resources.	Categorizes strategies and best practices for supporting or training end-users and their IT resources for a given scenario.

9	Use a variety of practices for making end-user systems secure.	Summarizes a variety of practices for securing an end-user system.	Uses a variety of practices to successfully secure an end-user system for a given scenario, such as strong passwords, anti-malware programs, and software firewalls.	Compares a variety of practices for securing end-user IT systems for a given scenario.
<i>An ability to demonstrate core IT competency in database and information management</i>				
	Learning Outcome	Emerging	Developed	Highly Developed
10	Describe the data management activities associated with the data lifecycle.	Lists some data management activities associated with the data lifecycle.	Describes the relevant data management activities associated with the data lifecycle for a given scenario.	Explains in detail the relevant data management activities associated with the data lifecycle for a given scenario.
11	Diagram a database design based on an identified scenario.	Discusses a database design which reflects the business requirements for an identified scenario.	Diagrams a database design which clearly reflects business requirements for an identified scenario.	Diagram a database design which clearly and logically reflects business requirements for an identified scenario and incorporates principles of good data organization.
12	Differentiate between public and private data.	Identifies public versus private data.	Differentiates between public and private data, supported by examples.	Differentiates between public and private data, supported by examples, and discusses proper handling of each.
13	Discuss applications of data analytics.	Identifies some applications of data analytics.	Discusses in detail applications of data analytics, such as informing decision making.	Analyzes a scenario and recommends applications of data analytics.

14	Discuss issues relevant to dealing with very large data sets, both structured and unstructured.	Recognizes some of the issues relevant to dealing with very large data sets.	Discusses issues relevant to dealing with very large data sets, such as collection, transfer, and storage.	Analyzes issues relevant to dealing with very large data sets, both structured and unstructured.
15	Identify database administration tasks.	Identifies some of the tasks required to administer a database.	Identifies most of the tasks required to administer a database, such as maintaining user accounts and performing backups.	Explains the tasks required to administer a database.
16	Produce simple database queries.	Produces a query which partially answers a question.	Produces a query which provides the exact data needed to completely answer a question.	Produces an efficient query which provides the exact data needed to completely answer a question with professionally formatted results.
17	Use data analytics to support decision making for a given scenario.	Discusses how data analytics could be used to support decision making for a given scenario.	Uses data analytics to identify meaningful options for decision making.	Uses data analytics efficiently and effectively to identify meaningful options for decision making.
<i>An ability to demonstrate core IT competency in digital media and immersive technology</i>				
	Learning Outcome	Emerging	Developed	Highly Developed
18	Differentiate among a variety of technology-based sensory interactions.	Lists a variety of sensory-based input and output methods.	Explains a variety of sensory-based input and output methods, such as touch screens, wearable computing, and voice interfaces.	Compares a variety of sensory-based input and output methods.

19	Differentiate among data types, data transfer protocols and file characteristics specific to the targeted use.	Lists data types, transfer protocols and file characteristics used in digital design.	Classifies data types, transfer protocols and file characteristics according to the targeted use.	Uses data types, transfer protocols and file characteristics appropriate to the targeted use.
20	Illustrate the activities of a digital media design process.	Lists the steps of a digital media design process.	Illustrate the activities of a digital media design process.	Creates a digital design utilizing activities of a digital media design process.
21	Implement communication principles into digital media design.	Executes a digital design that partially communicates the intended message.	Executes a digital design that communicates the intended message.	Executes a digital design that communicates the intended message and demonstrates standards appropriate to media.
<i>An ability to demonstrate core IT competency in networking and convergence</i>				
	Learning Outcome	Emerging	Developed	Highly Developed
22	Carry out basic computer network troubleshooting techniques.	Investigates a given networking problem without using appropriate methods or techniques.	Investigates a given networking problem using appropriate methods or techniques.	Solves a given networking problem using appropriate methods and provides documentation.
23	Describe the layers, protocols and components of the OSI model.	Lists the layers, protocols or components of the OSI model inaccurately or insufficiently.	Identifies the layers, names the major protocols and describes common components of the OSI model.	Explains the interaction of the OSI model layers in the encapsulation process.
24	Diagram the components of an integrated IT system.	Diagrams an integrated system insufficiently, or fails to explain the interactivity among subsystems.	Diagrams an integrated system, labels subsystems and explains how they interact to achieve the objective.	Implements an integrated system and explains how subsystems interact.

25	Differentiate among various computer networking models.	Lists various network models.	Differentiates among different network models, such as client-server, peer-to-peer, and cloud-based.	Differentiates among different network models, and identifies the model best suited for a given scenario.
26	Differentiate among various techniques for making a computer network secure.	Identifies a limited number of security methods.	Explains methods of securing a network appropriate to various threat types, such as firewalls and access control lists.	Implements network security measures appropriate to threat type.
27	Summarize the flow of data through a computer network scenario.	Summarizes the progression of data through a typical network insufficiently or without adequate explanation.	Summarizes the progression of data through a typical network, explaining the function of each networking device in turn.	Summarizes the progression of data through a typical network, explaining the function of each networking device in turn, and implements a working model.

An ability to demonstrate core IT competency in programming and application development

	Learning Outcome	Emerging	Developed	Highly Developed
28	Demonstrate best practices for designing end-user computing interfaces.	Identifies best practices for designing end-user interfaces without adequate demonstration.	Demonstrates best practices for designing end-user interfaces, such as Schneiderman's 8 Golden Rules of Interface Design.	Implements best practices when designing end-user interfaces.
29	Demonstrate the techniques of defensive programming and secure coding.	Lists strategies for creating secure code.	Explains the techniques of defensive programming and secure code, such as input validation and avoiding buffer overflows.	Implements programming solutions using defensive programming and secure coding techniques.

30	Diagram the phases of the Secure Software Development Lifecycle.	Illustrates some, but not all the phases of the Secure Development Lifecycle accurately.	Illustrates each phase of the Secure Software Development Lifecycle.	Outlines in detail each phase of the Secure Software Development Lifecycle.
31	Discuss software development methodologies.	Describes basic software development methodology terms.	Explains several software development methodologies and frameworks, such as SDLC and RAD.	Compares software development methodologies and frameworks.
32	Summarize the differences among various programming languages.	Identifies a few programming languages.	Explains the differences among several programming languages and categories of languages.	Compares strengths and weaknesses of several programming languages and categories of languages.
33	Use a programming or a scripting language to share data across an integrated IT system.	Summarizes how programs access and modify data across an integrated IT system.	Implements programming or scripting code to access and modify data across an integrated IT system.	Implements a programming solution which efficiently and securely accesses and modifies data across an integrated IT system.
34	Use a programming or a scripting language to solve a problem.	Summarizes a solution to the problem, but fails to implement a working solution in a programming or scripting language.	Implements a solution, written in a programming or scripting language to a given problem.	Structures the programming code in an optimal solution.
<i>An ability to demonstrate core IT competency in servers, storage and virtualization</i>				
	Learning Outcome	Emerging	Developed	Highly Developed
35	Differentiate among strategies for business continuity provisioning of IT resources at the enterprise level.	Lists some strategies for business continuity provisioning at the enterprise level.	Differentiates among strategies for business continuity provisioning at the enterprise level, such as cloud-	Differentiates among strategies for business continuity provisioning at the enterprise level and attributes

			based resources and off-site backup and archiving.	them to various scenarios.
36	Discuss data governance and its implications for users as well as IT professionals.	Identifies elements of data governance.	Explains key elements of data governance and discusses their implications for users and IT professionals.	Explains key elements of data governance and differentiates among implications of different policies and practices for users and IT professionals.
37	Identify a variety of enterprise-level digital storage technologies.	Lists some enterprise-level storage technologies.	Identifies a variety of enterprise-level storage technologies, such as SAN and RAID.	Differentiates among various enterprise-level storage technologies.
38	Implement an application of virtualization.	Discusses how virtualization could be used in a given scenario.	Implements a solution using virtualization for a given scenario.	Implements a secure and efficient solution using virtualization for a given scenario.
39	Modify a system to improve data confidentiality or regulatory compliance.	Discusses the modifications required to implement regulatory compliance and data confidentiality in a non-compliant system.	Modifies a system to improve data confidentiality or regulatory compliance.	Modifies a non-compliant system to ensure data confidentiality and regulatory compliance while maintaining efficiency and usability.
40	Summarize the implications of various cloud computing models.	Lists various cloud computing models.	Summarizes the implications of various cloud computing models, such as private, public and hybrid.	Summarizes the implications of various cloud computing models and classifies the models according to use.

41	Summarize the security implications and risks for distributed IT systems.	Recognizes some of the security issues and risks in a distributed IT system.	Summarizes the security issues and risks in a distributed IT system, and discuss their implications.	Analyzes the security issues and risks in a distributed IT system, and discusses their implications and mitigation strategies.
<i>An ability to function effectively as a member of a diverse team to accomplish common goals</i>				
	Learning Outcome	Emerging	Developed	Highly Developed
42	Use communication, negotiation, and collaboration skills as a member of a diverse team.	Uses communication, negotiation, and collaboration skills at a subpar level within a diverse team.	Uses communication, negotiation, and collaboration skills as a member of a diverse team.	Analyzes interpersonal interactions to improve collaboration within a diverse team.
<i>An ability to read and interpret technical information, as well as listen effectively to, communicate orally with, and write clearly for a wide range of audiences</i>				
	Learning Outcome	Emerging	Developed	Highly Developed
43	Describe the attitudes, knowledge and abilities associated with quality customer service.	Lists some of the attitudes, knowledge and abilities associated with quality customer service.	Describes the attitudes, knowledge and abilities associated with quality customer service.	Exemplifies the attitudes, knowledge and abilities associated with quality customer service.
44	Produce technical documentation responsive to an identified computing scenario.	Produces incomplete documentation, or documentation that does not conform to the format and syntax required for the identified scenario.	Produces complete documentation that conforms to the format and syntax required for the identified scenario.	Creates comprehensive documentation that conforms to the format and syntax required for the identified scenario and contributes to a collection of documentation.
45	Use documentation or a knowledge base to resolve a technical challenge in an identified computing scenario.	Locates information to resolve a technical challenge in the identified scenario.	Use documentation or information from a knowledge base to resolve a technical challenge in the	Edits to improve documentation or knowledge base information to resolve a technical challenge in the identified

			identified scenario.	scenario.
<i>An ability to engage in continuous learning as well as research and assess new ideas and information to provide the capabilities for lifelong learning</i>				
	Learning Outcome	Emerging	Developed	Highly Developed
46	Discuss significant trends and emerging technologies and their impact on our global society.	Recognizes significant trends and emerging technologies.	Discusses significant trends and emerging technologies and their impact on our global society, such as diversity in the IT workplace, and the digital divide.	Analyzes significant trends and emerging technologies and their impact on our global society.
<i>An ability to exhibit professional, legal, and ethical behavior</i>				
	Learning Outcome	Emerging	Developed	Highly Developed
47	Demonstrate professional behavior in response to an ethically-challenging scenario in computing.	Recognizes that choices in behavior exist in the face of ethical computing challenges.	Demonstrates professional behavior in response to an ethically-challenging scenario in computing.	Uses professional behavior in ethically-challenging computing situations.
48	Summarize the tenets of ethics and professional behavior promoted by international computing societies.	Names some of the tenets of ethics and professional behavior promoted by international computing societies.	Summarizes the tenets of ethics and professional behavior promoted by international computing societies, such as ACM, AITP, British Computing Society, and the Chinese Computing Federation.	Analyzes the tenets of ethics and professional behavior promoted by international computing societies.

An ability to demonstrate business awareness and workplace effectiveness

	Learning Outcome	Emerging	Developed	Highly Developed
49	Describe IT procurement processes for goods and services.	Recalls limited aspects of IT procurement processes for goods and services.	Describes IT procurement processes for goods and services, such as software licenses, maintenance contracts, product research and market analysis.	Illustrates IT procurement processes for goods and services.
50	Summarize the role of IT in supporting the mission and goals of an organization.	Recognize the role of IT in supporting the mission and goals of an organization.	Summarize the role of IT in supporting the mission and goals of an organization.	Illustrate with examples the role of IT in supporting the mission and goals of an organization.

ACM Core IT Learning Outcomes Mapped to Other Curricula, Classifications and Frameworks

www.capspace.org/ITmappings/

Using an online mapping tool developed by the CCECC and hosted at CAP Space.org, the core IT learning outcomes have been mapped to several well-known curricula, classifications and frameworks. Other mappings are currently being developed. Current mappings are available online at www.capspace.org/ITmappings/. Figure 3 illustrates the selection of online mappings.



Figure 3: Mappings of ACM Core IT Learning Outcomes to Other Curricula, Classifications and Frameworks

It is important to note that mapping core IT learning outcomes to existing ontologies is quite a different process than correlating courses to the core IT learning outcomes. See Figure 5 in Appendix E for details regarding the correlation process that was also developed by the CCECC and hosted at CAPSpace.org. An annotated list of the current and planned mappings follows.

U.S. Department of Labor Information Technology Competency Model

The U.S. Department of Labor Information Technology Competency Model was developed by the Employment and Training Administration (ETA) working together with industry leaders. It is intended to represent the technical competencies required for success in the IT industry. The U.S. Department of Labor IT Competency Model is available at www.careeronestop.org/COMPETENCYMODEL/pyramid.aspx?IT=Y. A mapping of core IT learning outcomes to the IT Competency model is available at www.capspace.org/ITmappings/ by selecting this option from the dropdown menu.

Knowledge Units of the ACM/IEEE-CS 2008 Curriculum Guidelines for Undergraduate Degree Programs in Information Technology

A joint task force of the ACM and the IEEE Computer Society published a revision of *Curriculum Guidelines for Undergraduate Degree Programs in Information Technology* in 2008 targeting four-year educational programs at the baccalaureate level. The guidelines include a body of IT knowledge catalogued into discrete knowledge units.

The baccalaureate IT curricular guidelines report can be found at

www.acm.org/education/curricula/IT2008%20Curriculum.pdf. A cross-referencing of the ACM core IT learning outcomes to the Knowledge Units in *Curriculum Guidelines for Undergraduate Degree Programs in Information Technology* are available at www.capspace.org/ITmappings/ by selecting this option from the dropdown menu.

CSTA Standards

The Computer Science Teachers Association (CSTA) in cooperation with the ACM has provided a comprehensive set of computer science/information technology education standards targeted at K-12 institutions in the *CSTA K-12 Computer Science Standards*. The CSTA 2011 revised standards can be found at http://csta.acm.org/Curriculum/sub/CurrFiles/CSTA_K-12_CSS.pdf. A mapping of the ACM core IT learning outcomes to Levels 3B & 3C of the CSTA standards and can be accessed at www.capspace.org/ITmappings/ by selecting this option from the dropdown menu.

ACM Computing Classification System

The 2012 ACM Computing Classification System lists and categorizes concepts relating to the computing industry into a standardized resource that is available through the ACM Digital Library. The classification system can be accessed at <http://dl.acm.org/ccs.cfm?CFID=347257426&CFTOKEN=36842104>. The ACM core IT learning outcomes categorized according to the ACM Computing Classification System are available at www.capspace.org/ITmappings/ by selecting this option from the dropdown menu.

ABET CAC Criteria for Information Technology Programs

The Accreditation Board for Engineering and Technology (ABET) publishes criteria for accrediting computing (CAC) programs, which include general criteria and program criteria. The program criteria provide discipline-specific accreditation criteria which must be satisfied by any program seeking ABET accreditation.

The 2014-2015 criteria for accrediting computing programs, which includes criteria for Information Technology programs, can be accessed at www.abet.org/cac-criteria-2014-2015/. A mapping of the ACM core IT learning outcomes to this ABET CAC can be accessed at www.capspace.org/ITmappings/ by selecting this option from the dropdown menu.

The European e-Competence Framework

The European e-Competence Framework (e-CF) provides a common listing of competencies including knowledge, skills and proficiency levels required by the Information and Communication Technology (ICT) industry across Europe as a sector-specific implementation of the European Qualifications Framework (EQF). The framework is organized into 40 competencies, each presented at five proficiency levels to address the needs of businesses and other organizations in public and private sectors. The full e-CF document can be found at www.ecompetences.eu.

The core IT learning outcomes have been mapped to the appropriate e-CF competencies at the first and second proficiency levels and can be accessed at www.capspace.org/ITmappings/ by selecting this option from the dropdown menu.

Common Criteria for Information Technology Security Evaluation

The Common Criteria for Information Technology Security Evaluation (abbreviated as Common Criteria or CC) is an international standard (ISO/IEC 15408) for computer security certification. More information is available from www.commoncriteriaportal.org. The core IT learning outcomes are in the process of being mapped to this international standard. Visit www.capspace.org/ITmappings/ to view it.

NICE Framework 2.0

The National Initiative for Cybersecurity Education (NICE) has developed the National

Cybersecurity Workforce Framework 2.0 (“the Framework”) to provide a common understanding of and lexicon for cybersecurity work. Defining the cybersecurity population consistently, using standardized terms is an essential step in ensuring that our country is able to educate, recruit, train, develop, and retain a highly-qualified workforce. The NICE framework is available from <http://csrc.nist.gov/nice/framework/>. The core IT learning outcomes are in the process of being mapped to version 2.0 of the NICE Framework. Visit www.capspace.org/ITmappings/ to view it.

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Appendix A: Committee's Charge and Process

Charge

The ACM Committee for Computing Education in Community Colleges (CCECC), at the direction of the ACM Education Board, convened a task force to produce curricular guidance for associate-degree programs in Information Technology (IT) that are:

- Built from the ground up on a framework of learning outcomes.
- Constituted by core IT learning outcomes assembled into a competency framework.
- Influenced by the current and future needs of business and industry, by professional certifications and related curricula, by government and standards bodies, and by new and emerging technology.
- Designed in a manner that provides for staying power, breadth and adaptability.
- International in application.
- Accompanied by meaningful evaluation metrics/assessment rubrics.

Process

In fulfilling the Committee's charge, the ACM CCECC employed a quasi-Delphi Technique to pursue a multiphase, three-year process (2011-2014) of collaboration and debate among representatives from two-year college faculty, business and industry, and certification/standards bodies, including peer dissemination and public comment on two draft results (Strawman and Ironman), and oversight by a team of experts in student learning assessment.

Appendix B: Participants and External Reviewers

The ACM CCECC wishes to acknowledge and individually thank the following persons who generously served as either a task force participant or external reviewer for this project in its many phases of development.

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Appendix C: Bloom's Revised Taxonomy

www.capspace.org/BloomsTaxonomy/

The foundational *Taxonomy of Educational Objectives: A Classification of Educational Goals* was established in 1956 by Dr. Benjamin Bloom, an educational psychologist, and is often referred to as Bloom's Taxonomy. This classification divided educational objectives into three learning domains: Cognitive (knowledge), Affective (attitude) and Psychomotor (skills). In 2000, Lorin Anderson and David Krathwohl updated Bloom's seminal framework to create Bloom's Revised Taxonomy, focusing on the Cognitive and Affective Domains. As described below and in Figure 4, the ACM Committee for Computing Education in Community Colleges has adopted Bloom's Revised Taxonomy for the assessment of student learning outcomes in its computing curricula.

It is important to note that in the framework of Bloom's Revised Taxonomy learners need not start at the lowest taxonomic level and work up; rather, the learning process can be initiated at any point, and the lower taxonomic levels will be subsumed within the learning scaffold. To wit:

- Before we can understand a concept we have to remember it;
- Before we can apply the concept we must understand it;
- Before we analyze it we must be able to apply it;
- Before we can evaluate its impact we must have analyzed it; and
- Before we can create, we must have remembered, understood, applied, analyzed and evaluated.

In its computing curricula, the ACM Committee for Computing Education in Community Colleges uses the **Cognitive domain** to assess student mastery of learning outcomes. There are six levels in the taxonomy for the Cognitive domain, progressing from the lowest order processes to the highest:

1. **Remembering** - Retrieving, recalling, or recognizing information from memory. Students can recall or remember information. *Note: This process is the most basic thinking skill.*

2. **Understanding** - Constructing meaning or explaining material from written, spoken or graphic sources. Students can explain ideas or concepts.
3. **Applying** - Using learned materials or implementing materials in new situations. Students can use/apply information in a new way.
4. **Analyzing** - Breaking material or concepts into parts, determining how the parts relate or interrelate to one another or to an overall structure or purpose. Students can distinguish between different parts.
5. **Evaluating** - Assessing, making judgments and drawing conclusions from ideas, information, or data. Students can justify a stand or decision.
6. **Creating** - Putting elements together or reorganizing them into a new way, form or product. Students can create a new product. *Note: This process is the most difficult mental function.*

Assessment by Bloom's Level



Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
<i>Define</i>	<i>Classify</i>	<i>Apply</i>	<i>Analyze</i>	<i>Appraise</i>	<i>Assemble</i>
<i>Duplicate</i>	<i>Convert</i>	<i>Calculate</i>	<i>Attribute</i>	<i>Argue</i>	<i>Construct</i>
<i>Find</i>	<i>Demonstrate</i>	<i>Carry out</i>	<i>Categorize</i>	<i>Assess</i>	<i>Create</i>
<i>Identify</i>	<i>Describe</i>	<i>Edit</i>	<i>Compare</i>	<i>Choose</i>	<i>Design</i>
<i>Label</i>	<i>Differentiate</i>	<i>Diagram</i>	<i>Contrast</i>	<i>Critique</i>	<i>Develop</i>
<i>List</i>	<i>Discuss</i>	<i>Execute</i>	<i>Decompose</i>	<i>Debate</i>	<i>Devise</i>
<i>Locate</i>	<i>Exemplify</i>	<i>Illustrate</i>	<i>Deconstruct</i>	<i>Defend</i>	<i>Formulate</i>
<i>Memorize</i>	<i>Explain</i>	<i>Implement</i>	<i>Deduce</i>	<i>Estimate</i>	<i>Hypothesize</i>
<i>Name</i>	<i>Infer</i>	<i>Investigate</i>	<i>Discriminate</i>	<i>Evaluate</i>	<i>Invent</i>
<i>Recall</i>	<i>Interpret</i>	<i>Manipulate</i>	<i>Distinguish</i>	<i>Judge</i>	<i>Make</i>
<i>Recognize</i>	<i>Paraphrase</i>	<i>Modify</i>	<i>Examine</i>	<i>Justify</i>	<i>Plan</i>
<i>Retrieve</i>	<i>Report</i>	<i>Operate</i>	<i>Integrate</i>	<i>Support</i>	
<i>Select</i>	<i>Summarize</i>	<i>Perform</i>	<i>Organize</i>	<i>Test</i>	
<i>State</i>	<i>Translate</i>	<i>Produce</i>	<i>Outline</i>	<i>Value</i>	
		<i>Solve</i>	<i>Structure</i>	<i>Verify</i>	
		<i>Use</i>			
		<i>Write</i>			

Figure 4: Active Learning Verbs of Bloom's Revised Taxonomy

Appendix D: Curriculum Champions

Champions are organizations that appreciate the importance of robust associate-degree IT programs, make a commitment to the academic foundation of IT students, and promote education that meaningfully prepares graduates as future employees and practitioners. Representatives from business and industry as well as two-year college faculty collaborated with the ACM CCECC to debate, review, and support this ACM curricular guidance that expresses core IT competencies across IT associate-degree programs, as outlined in this document. Other champions including community colleges and NSF-ATE centers reviewed the curricular guidance and equally support this ACM curricular guidance. All of our champions believe there are direct benefits to their respective institutions and to date, include the following:

- ✓ BATEC (Broadening Advanced Technological Education Connections)
- ✓ Bluegrass Community and Technical College (Kentucky)
- ✓ C-ID Information Systems Faculty Discipline Review Group (California)
- ✓ Cisco
- ✓ Citrix
- ✓ CSSIA (National Center for Systems Security and Information Assurance)
- ✓ CSTA (Computer Science Teachers Association)
- ✓ National CyberWatch Center
- ✓ Dell
- ✓ EMC²
- ✓ Estrella Mountain Community College (Arizona)
- ✓ Google
- ✓ IBM
- ✓ Intel
- ✓ Juniper Networks
- ✓ Maricopa Community College District (Arizona)
- ✓ Microsoft
- ✓ Mount Washington College (New Hampshire)
- ✓ MPICT (Mid-Pacific Information and Communication Technologies Center)
- ✓ NetApp
- ✓ Oracle
- ✓ Portland Community College (Oregon)
- ✓ Union County College (New Jersey)

Appendix E: ACM Core IT Learning Outcomes

www.capspace.org/IT/

An ability to demonstrate core IT competency in client computing and user support	
1	Carry out trouble-shooting strategies for resolving an identified end-user IT problem.
2	Differentiate among various operating systems.
3	Explain the process of authentication and authorization between end-user devices and computing network resources.
4	Identify a variety of assistive or adaptive technologies and universal design considerations.
5	Identify basic components of an end-user IT system.
6	Implement a hardware and software configuration responsive to an identified scenario.
7	Summarize life-cycle strategies for replacement, reuse, recycling IT technology and resources.
8	Summarize strategies to support or train users with their IT resources.
9	Use a variety of practices for making end-user IT systems secure.
An ability to demonstrate core IT competency in database and information management	
10	Describe the data management activities associated with the data lifecycle.
11	Diagram a database design based on an identified scenario.
12	Differentiate between public and private data.
13	Discuss applications of data analytics.
14	Discuss issues relevant to dealing with very large data sets, both structured and unstructured.
15	Identify database administration tasks.
16	Produce simple database queries.
17	Use data analytics to support decision making for a given scenario.
An ability to demonstrate core IT competency in digital media and immersive technology	
18	Differentiate among a variety of technology-based sensory interactions.
19	Differentiate among data types, data transfer protocols and file characteristics specific to the targeted use.
20	Illustrate the activities of a digital media design process.
21	Implement communication principles into digital media design.
An ability to demonstrate core IT competency in networking and convergence	
22	Carry out basic computer network troubleshooting techniques.
23	Describe the layers, protocols and components of the OSI model.
24	Diagram the components of an integrated IT system.
25	Differentiate among various computer networking models.
26	Differentiate among various techniques for making a computer network secure.
27	Summarize the flow of data through a computer network scenario.
An ability to demonstrate core IT competency in programming and application development	
28	Demonstrate best practices for designing end-user computing interfaces.
29	Demonstrate the techniques of defensive programming and secure coding.
30	Diagram the phases of the Secure Software Development Lifecycle.
31	Discuss software development methodologies.
An ability to demonstrate core IT competency in programming and application development (continued)	
32	Summarize the differences among various programming languages.
33	Use a programming or a scripting language to share data across an integrated IT system.
34	Use a programming or a scripting language to solve a problem.

An ability to demonstrate core IT competency in servers, storage and virtualization	
35	Differentiate among strategies for business continuity provisioning of IT resources at the enterprise level.
36	Discuss data governance and its implications for users as well as IT professionals.
37	Identify a variety of enterprise-level digital storage technologies.
38	Implement an application of virtualization.
39	Modify a system to improve data confidentiality or regulatory compliance.
40	Summarize the implications of various cloud computing models.
41	Summarize the security implications and risks for distributed IT systems.
An ability to function effectively as a member of a diverse team to accomplish common goals	
42	Use communication, negotiation, and collaboration skills as a member of a diverse team.
An ability to read and interpret technical information, as well as listen effectively to, communicate orally with, and write clearly for a wide range of audiences	
43	Describe the attitudes, knowledge and abilities associated with quality customer service.
44	Produce technical documentation responsive to an identified computing scenario.
45	Use documentation or a knowledge base to resolve a technical challenge in an identified computing scenario
An ability to engage in continuous learning as well as research and assess new ideas and information to provide the capabilities for lifelong learning	
46	Discuss significant trends and emerging technologies and their impact on our global society.
An ability to exhibit professional, legal, and ethical behavior	
47	Demonstrate professional behavior in response to an ethically-challenging scenario in computing.
48	Summarize the tenets of ethics and professional behavior promoted by international computing societies.
An ability to demonstrate business awareness and workplace effectiveness	
49	Describe IT procurement processes for goods and services.
50	Summarize the role of IT in supporting the mission and goals of an organization.

Appendix F: Certificate and Degree Program Correlations

www.capspace.org/correlation/

Correlations that align with the ACM core IT learning outcomes demonstrate the adaptability of this competency-based curricular approach to a variety of computing courses, certificates, and degree programs. Certificate and degree program correlations are listed here in Appendix E and online at www.capspace.org/ITcorrelations/. More correlations are welcome. If your college is interested in correlating its certificate and/or degree program courses, visit www.capspace.org/correlation/ for the correlation template and detailed instructions.

See Figure 5.



Figure 5: Certificate and Degree Program Correlations with ACM Core IT Learning Outcomes

Institution Name: Bay College, Escanaba, MI
Institution URL: www.baycollege.edu
Contact Name: Prof. Karl Linderoth, CNSS/GIS Faculty
Program Title: Computer Network Systems and Security
Program Type: Associate in Applied Science (A.A.S.)
Program URL: www.baycollege.edu/Academics/Areas-of-Study/Computer-Network-Systems.aspx
Course Descriptions:

1. **CNSS 105: Digital Logic Principles** - This course covers the basic principles of electricity and digital electronics involved in the operation of computers and network systems. Topics include waveform generation and transmission, Boolean Arithmetic, and basic circuit operations. All topics are covered with respect to their effect on modern computer and network systems.
2. **CNSS 130: Introduction to Local Area Networks** - Employment in information technology, whether in a software or hardware field, requires in-depth knowledge of computers and networks and the vast amount of terminology relating to this area. This course is designed to prepare students very well for both employment and CompTIA network+ certification.
3. **CNSS 150: A+ Computer Hardware Troubleshooting** - This course is an introduction to Personal Computer hardware and software. Using a theoretical and hands-on approach, students will learn the skills needed to install, configure, and service hardware, operating systems, and applications. In addition, students will learn to configure stand alone or networked computers for reliability and security. This course maps to CompTIA A+ objectives.
4. **CNSS 220: Network Design** - This course provides hands-on understanding of how to design network topologies, and install and manage network devices (switch, router, AP) and identify network problems, and troubleshoot. Students will also learn Cisco Command Line interface and terminology. Prerequisite: CNSS-130.
5. **CNSS 230: Introduction to Unix using Linux**- This course is intended to teach the fundamentals of the Unix operating system to students with little or no prior experience in Unix. It will cover open source topics and tools needed to work effectively in a Unix system environment. Familiarity with computers and with the Windows operating system is required to be successful. This course also covers open source software and Linux distributions. Prerequisites: CNSS-150.
6. **CNSS 231: Advanced Linux** - In depth look at Linux, focusing on proper installation, user administration, and system monitoring. This course will be presented (in seat or hybrid online) in a "hands-on approach." Students will either install Linux on their own or lab system or use VMWare operating system images to perform work. Labs include user\group management, logging, NFS, SAMBA, RAID, DHCP, IPTABLES, and implementing Security. Prerequisite: CNSS-230.
7. **CNSS 250: Windows Networking I** - Course introduces students to Network Administration using the latest Microsoft Network Operating System. Students will load server, configure Active Directory, and use server to perform labs. Course maps directly to Microsoft Certified Technology Specialist (MCTS) and prepares the student for certification. Emphasis on administration of users, group policies, Active Directory design and concepts, and security concepts. Accepted by most universities as CSCI transfer. Prerequisites: CNSS-130 and CNSS-150.

8. **CNSS 251: Windows Networking II** - Course focuses on advanced Windows network administration. Course maps directly to Microsoft Certified Systems Administrator and Microsoft Certified Systems Engineer certifications. Emphasis on role of administration of network devices, fault tolerance, Active Directory and DNS troubleshooting, Group Policies, Web Servers, Virtual Private Networking, Interoperability with other NOS', and IP routed networking. Students load and administer Windows servers, workstations, hubs, routers, switches, UPS, and security software. Prerequisite: CNSS-250.
9. **CNSS 260: Network Security** - This course covers the skills needed to protect computer systems, network systems, and information assets (information assurance). Students will apply the latest methods, with a focus on information system security protection. Understanding key elements like the "Human Firewall" are explored in depth. Prerequisite: CNSS-220; and Student must pass a criminal background check.
10. **CNSS 272: CNSS 272 Co-op\Internship Work Experience** - Directly related Information Technology work experience designed to provide students with "on-the-job" experience at a business workplace. Outcomes of this experience will include employability skills, interpersonal communication skills, and information technology skills. Prerequisites: Student has taken 24 credits in the CNSS program. Student must pass a criminal background check.

Table 3: Bay College Program Correlation

	<i>Learning Outcome</i>	CNSS 105	CNSS 130	CNSS 150	CNSS 220	CNSS 230	CNSS 231	CNSS 250	CNSS 251	CNSS 260	CNSS 272
1	<i>Carry out trouble-shooting strategies for resolving an identified end-user IT problem.</i>		✓	✓	✓			✓	✓		✓
2	<i>Differentiate among various operating systems.</i>			✓		✓	✓	✓	✓		
3	<i>Explain the process of authentication and authorization between end-user devices and network resources.</i>			✓		✓	✓	✓	✓		
4	<i>Identify a variety of assistive or adaptive technologies and universal design considerations.</i>		✓	✓	✓			✓			
5	<i>Identify basic components of an end-user IT system.</i>	✓		✓				✓			
6	<i>Implement a hardware and software configuration responsive to an identified scenario.</i>		✓	✓	✓			✓	✓		
7	<i>Summarize life-cycle strategies for replacement, reuse, recycling IT technology and resources.</i>					✓	✓				✓
8	<i>Summarize strategies to support or train users with their IT resources.</i>			✓				✓	✓		✓

	Learning Outcome	CNSS 105	CNSS 130	CNSS 150	CNSS 220	CNSS 230	CNSS 231	CNSS 250	CNSS 251	CNSS 260	CNSS 272
9	<i>Use a variety of practices for making end-user systems secure.</i>			✓				✓	✓	✓	✓
10	<i>Describe the data management activities associated with the data lifecycle.</i>					✓	✓	✓	✓		
11	<i>Diagram a database design based on an identified scenario.</i>						✓	✓	✓		
12	<i>Differentiate between public and private data.</i>				✓	✓	✓	✓	✓		
13	<i>Discuss applications of data analytics.</i>						✓		✓		
14	<i>Discuss issues relevant to dealing with very large data sets, both structured and unstructured.</i>							✓	✓	✓	
15	<i>Identify database administration tasks.</i>							✓	✓		
16	<i>Produce simple database queries.</i>					✓	✓	✓	✓		
17	<i>Use data analytics to support decision making for a given scenario.</i>						✓		✓		
18	<i>Differentiate among a variety of technology-based sensory interactions.</i>				✓	✓	✓	✓	✓		
19	<i>Differentiate among data types, data transfer protocols and file characteristics specific to the targeted use.</i>						✓	✓	✓		
20	<i>Illustrate the activities of a digital media design process.</i>		✓					✓			
21	<i>Implement communication principles into digital media design.</i>		✓					✓			
22	<i>Carry out basic computer network troubleshooting techniques.</i>		✓	✓	✓	✓	✓	✓	✓		✓
23	<i>Describe the layers, protocols and components of the OSI model.</i>		✓		✓					✓	
24	<i>Diagram the components of an IT integrated system.</i>			✓					✓		

	Learning Outcome	CNSS 105	CNSS 130	CNSS 150	CNSS 220	CNSS 230	CNSS 231	CNSS 250	CNSS 251	CNSS 260	CNSS 272
25	<i>Differentiate among various computer networking models.</i>			✓	✓						
26	<i>Differentiate among various techniques for making a computer network secure.</i>			✓	✓			✓	✓	✓	✓
27	<i>Summarize the flow of data through a computer network scenario.</i>							✓	✓		✓
28	<i>Demonstrate best practices for designing end-user computing interfaces.</i>					✓	✓			✓	
29	<i>Demonstrate the techniques of defensive programming and secure coding.</i>					✓	✓				
30	<i>Diagram the phases of the Secure Software Development Lifecycle.</i>					✓	✓			✓	
31	<i>Discuss software development methodologies.</i>					✓	✓			✓	
32	<i>Summarize the differences among various programming languages.</i>					✓	✓				
33	<i>Use a programming or a scripting language to share data across an integrated IT system.</i>					✓	✓	✓	✓	✓	
34	<i>Use a programming or a scripting language to solve a problem.</i>					✓	✓	✓	✓	✓	
35	<i>Differentiate among strategies for business continuity provisioning of IT resources at the enterprise level.</i>		✓	✓				✓	✓		
36	<i>Discuss data governance and its implications for users as well as IT professionals.</i>			✓				✓	✓		
37	<i>Identify a variety of enterprise-level digital storage technologies.</i>			✓				✓	✓		
38	<i>Implement an application of virtualization.</i>			✓	✓	✓	✓	✓	✓	✓	
39	<i>Modify a system to improve data confidentiality or regulatory compliance.</i>			✓	✓	✓	✓	✓	✓	✓	✓
40	<i>Summarize the implications of various cloud computing models.</i>			✓	✓			✓	✓	✓	

	Learning Outcome	CNSS 105	CNSS 130	CNSS 150	CNSS 220	CNSS 230	CNSS 231	CNSS 250	CNSS 251	CNSS 260	CNSS 272
41	<i>Summarize the security implications and risks for distributed IT systems.</i>			✓	✓			✓	✓	✓	
42	<i>Use communication, negotiation, and collaboration skills as a member of a diverse team.</i>		✓	✓				✓	✓		✓
43	<i>Describe the attitudes, knowledge and abilities associated with quality customer service.</i>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
44	<i>Produce technical documentation responsive to an identified computing scenario.</i>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
45	<i>Use documentation or a knowledge base to resolve a technical challenge in an identified computing scenario.</i>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
46	<i>Discuss significant trends and emerging technologies and their impact on our global society.</i>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
47	<i>Demonstrate professional behavior in response to an ethically-challenging scenario in computing.</i>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
48	<i>Summarize the tenets of ethics and professional behavior promoted by international computing societies.</i>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
49	<i>Describe IT procurement processes for goods and services.</i>		✓					✓	✓		✓
50	<i>Summarize the role of IT in supporting the mission and goals of an organization.</i>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Institution Name: Bluegrass Community and Technical College, Lexington, KY
Institution URL: www.bluegrass.kctcs.edu
Contact Name: Prof. Cindy Tucker, CIT Faculty
Program Title: Computer & Information Technologies
Program Type: Associate in Applied Science (A.A.S.)
Program URL: www.bluegrass.kctcs.edu/en/csis/CIT.aspx
Course Descriptions:

1. **CIT 105: Introduction to Computers** - Provides an introduction to the computer and the convergence of technology as used in today's global environment. Introduces topics including computer hardware and software, file management, the Internet, e-mail, the social web, green computing, security and computer ethics. Presents basic use of application, programming, systems, and utility software.
2. **CIT 111: Computer Hardware and Software** - Presents a practical view of computer hardware and client operating systems. Covers computer hardware components; troubleshooting, repair, and maintenance; operating system interfaces and management tools; networking components; computer security; and operational procedures.
3. **CIT 120: Computational Thinking** - Promotes understanding of computer programming and logic by teaching students to "think like a computer." Covers skills needed to develop and design language-independent solutions to solve computer-related problems. Covers development and design basics including use of variables, control and data structures, and principles of command-line and object-oriented languages.
4. **CIT 150: Internet Technologies** - Provides students with a study of traditional and emerging Internet technologies. Covers topics including Internet fundamentals, Internet applications, Internet delivery systems, and Internet client/server computing. Provides a hands-on experience and some rudimentary programming in an Internet environment.
5. **CIT 160: Introduction to Networking Concepts** - Introduces technical level concepts of non-vendor specific networking including technologies, media, topologies, devices, management tools, and security. Provides the basics of how to manage, maintain, troubleshoot, install, operate, and configure basic network infrastructure.
6. **CIT 170: Database Design Fundamentals** - Provides an overview of database and database management system concepts, internal design models, normalization, network data models, development tools, and applications.
7. **CIT 180: Security Fundamentals** - Introduces basic computer and network security concepts and methodologies. Covers principles of security; compliance and operational security; threats and vulnerabilities; network security; application, data, and host security; access control and identity management; and cryptography.
8. **CIT 149: Java I Programming** - Introduces students to fundamental programming concepts using the Java programming language. Topics include data types, control structures, simple data structures, error-handling, object-oriented programming, graphical user interfaces, and modular programming.
9. **CIT 291: CIT Capstone** - Apply acquired techniques, knowledge, and skills to successfully analyze, design, and plan a CIT project. Develop key project management and system analysis deliverables in a portfolio.

Table 4: Bluegrass Community and Technical College Program Correlation

	Learning Outcome	CIT 105	CIT 111	CIT 120	CIT 150	CIT 160	CIT 170	CIT 180	CIT 149	CIT 291
1	<i>Carry out trouble-shooting strategies for resolving an identified end-user IT problem.</i>		✓			✓				
2	<i>Differentiate among various operating systems.</i>		✓							
3	<i>Explain the process of authentication and authorization between end-user devices and network resources.</i>							✓		
4	<i>Identify a variety of assistive or adaptive technologies and universal design considerations.</i>	✓								
5	<i>Identify basic components of an end-user IT system.</i>	✓	✓							✓
6	<i>Implement a hardware and software configuration responsive to an identified scenario.</i>		✓							
7	<i>Summarize life-cycle strategies for replacement, reuse, recycling IT technology and resources.</i>	✓								✓
8	<i>Summarize strategies to support or train users with their IT resources.</i>		✓							
9	<i>Use a variety of practices for making end-user systems secure.</i>		✓					✓		
10	<i>Describe the data management activities associated with the data lifecycle.</i>						✓			
11	<i>Diagram a database design based on an identified scenario.</i>						✓			
12	<i>Differentiate between public and private data.</i>		✓						✓	
13	<i>Discuss applications of data analytics.</i>						✓		✓	
14	<i>Discuss issues relevant to dealing with very large data sets, both structured and unstructured.</i>									

	Learning Outcome	CIT 105	CIT 111	CIT 120	CIT 150	CIT 160	CIT 170	CIT 180	CIT 149	CIT 291
15	<i>Identify database administration tasks.</i>						✓			
16	<i>Produce simple database queries.</i>						✓			
17	<i>Use data analytics to support decision making for a given scenario.</i>						✓		✓	
18	<i>Differentiate among a variety of technology-based sensory interactions.</i>	✓								
19	<i>Differentiate among data types, data transfer protocols and file characteristics specific to the targeted use.</i>				✓	✓			✓	
20	<i>Illustrate the activities of a digital media design process.</i>									
21	<i>Implement communication principles into digital media design.</i>									
22	<i>Carry out basic computer network troubleshooting techniques.</i>		✓			✓				
23	<i>Describe the layers, protocols and components of the OSI model.</i>				✓	✓				
24	<i>Diagram the components of an integrated IT system.</i>	✓				✓				
25	<i>Differentiate among various computer networking models.</i>					✓				
26	<i>Differentiate among various techniques for making a computer network secure.</i>		✓			✓		✓		
27	<i>Summarize the flow of data through a computer network scenario.</i>			✓		✓				
28	<i>Demonstrate best practices for designing end-user computing interfaces.</i>			✓					✓	
29	<i>Demonstrate the techniques of defensive programming and secure coding.</i>								✓	
30	<i>Diagram the phases of the Secure Software Development Lifecycle.</i>								✓	✓

	Learning Outcome	CIT 105	CIT 111	CIT 120	CIT 150	CIT 160	CIT 170	CIT 180	CIT 149	CIT 291
31	<i>Discuss software development methodologies.</i>	✓		✓					✓	✓
32	<i>Summarize the differences among various programming languages.</i>			✓						
33	<i>Use a programming or a scripting language to share data across an integrated IT system.</i>				✓					
34	<i>Use a programming or a scripting language to solve a problem.</i>			✓			✓		✓	
35	<i>Differentiate among strategies for business continuity provisioning of IT resources at the enterprise level.</i>							✓		
36	<i>Discuss data governance and its implications for users as well as IT professionals.</i>									
37	<i>Identify a variety of enterprise-level digital storage technologies.</i>									
38	<i>Implement an application of virtualization.</i>		✓							
39	<i>Modify a system to improve data confidentiality or regulatory compliance.</i>		✓					✓		
40	<i>Summarize the implications of various cloud computing models.</i>	✓			✓					
41	<i>Summarize the security implications and risks for distributed IT systems.</i>							✓		
42	<i>Use communication, negotiation, and collaboration skills as a member of a diverse team.</i>									✓
43	<i>Describe the attitudes, knowledge and abilities associated with quality customer service.</i>		✓							✓
44	<i>Produce technical documentation responsive to an identified computing scenario.</i>			✓					✓	✓
45	<i>Use documentation or a knowledge base to resolve a technical challenge in an identified computing scenario.</i>								✓	

	Learning Outcome	CIT 105	CIT 111	CIT 120	CIT 150	CIT 160	CIT 170	CIT 180	CIT 149	CIT 291
46	<i>Discuss significant trends and emerging technologies and their impact on our global society.</i>	✓								
47	<i>Demonstrate professional behavior in response to an ethically-challenging scenario in computing.</i>	✓	✓							✓
48	<i>Summarize the tenets of ethics and professional behavior promoted by international computing societies.</i>									✓
49	<i>Describe IT procurement processes for goods and services.</i>									✓
50	<i>Summarize the role of IT in supporting the mission and goals of an organization.</i>									

Institution Name: Broward College, Fort Lauderdale, FL
Institution URL: www.broward.edu
Contact Name: Annie Myers, District Director
Program Title: Accelerated Competency-based Computer Systems Specialist
Program Type: Associate in Science (A.S.)
Program URL: www.broward.edu/computerspecialist

Course Descriptions:

1. **CGS 1060C: Computer and Internet Literacy** - This is an introductory course in basic computer and internet use. It covers computer hardware and software fundamentals (including the use of Windows), key productivity applications (including word processing, spreadsheets, and presentation systems), and living in an online world (including network fundamentals, e-mails, and the effective use of the Internet as a communication tool and information resource). Students will develop basic computer skills to aid them with college studies and workforce readiness. Hands-on use of a personal computer is required.
2. **CTS 1133C: A+ Essentials** - This course provides students with the knowledge required to assemble components based on customer requirements, install, configure and maintain devices, PCs and software for end users, understand the basics of networking and security/forensics, properly and safely diagnose, resolve and document common hardware and software issues while applying troubleshooting skills. Successful candidates will also provide appropriate customer support; understand the basics of virtualization, desktop imaging, and deployment.
3. **CTS 2131C: A+ Practicals** - This course provides students with the skills required to install, configure, upgrade, and maintain PC workstations, the Windows OS and SOHO networks, in addition the student will be able to utilize troubleshooting techniques and tools to effectively and efficiently resolve PC, OS, and network connectivity issues and implement security practices.
4. **CIS 1000C: Intro to Computer Science** - This course is designed to provide students with a broad perspective of the field of Computer Science, from core issues and concepts inherent to the discipline of computing, to the various sub-disciplines of computer science. Topics include: Number Systems and Data Representation; Computer Components and Architecture including Gates and Circuits; Problem Solving and Systems Development Methodologies; Low-Level and High- Level Programming Languages; Abstract Data Representations and Algorithms; Operating Systems, File Systems and Directories; Information Systems; Artificial Intelligence; Simulation, Graphics, and Other Applications; Networks and the World Wide Web.
5. **COP 1334C: Intro to C++** - This course provides an introduction to computer program design and development using the C++ language. A structured, multi-phase, program development process featuring a series of steps involving problem definition, top-down design, and formal program specification is stressed. The course is intended to provide the novice programming student with the techniques needed to develop well-documented, structured computer programs.
6. **CIS 1513C: Project Management** - This course examines the organization, planning, and controlling of projects and provides practical knowledge on managing project scope, schedule and resources. Topics include project life cycle, work breakdown structure and Gantt charts, network diagrams, scheduling techniques, and resource allocation decisions. Concepts are applied through team projects and tutorials using project management software. Prerequisite: CGS1060C or placement.

7. **CET 2472C: Advanced Networking** - This course provides students with important knowledge and skills required to implement a defined network architecture with basic network security to configure, maintain, and troubleshoot network devices using appropriate network tools, to understand the features and purpose of network technologies, and to make basic solution recommendations, analyze network traffic, and be familiar with common protocols and media types.
8. **CTS 2120C: Security +** - This course provides the student with an understanding of the computer, network, infrastructure, and information security issues faced by industry worldwide. Expertise necessary to combat and protect intellectual property from theft and destruction are also developed. The skills developed by students who complete this course will prepare them for the Security+ certification exam.
9. **CGS 1557C: Internet Site Design** - This course is an entry-level course that provides students with baseline technical knowledge and skills of Internet, intranet, and extranet technologies. Students will gain a basic knowledge and/or competency of Internet skills and tasks in 3 core content areas: Internet Business Foundations, Site Development Foundations, and Network Technology Foundations.
10. **CGS 1540C: Database Management** - This course is an introduction to database management. Using appropriate database software, students will learn to maintain and manipulate data in an organized, accessible and accurate manner. Emphasis is placed on the use of microcomputer database management software for common business applications.

Table 5: Broward College Program Correlation

	Learning Outcome	CGS 1060C	CTS 1133C	CTS 2131C	CIS 1000C	COP 1334C	CIS 1513C	CET 2472C	CTS 2120C	CGS 1557C	CGS 1540C
1	<i>Carry out trouble-shooting strategies for resolving an identified end-user IT problem.</i>	✓	✓	✓	✓			✓	✓	✓	
2	<i>Differentiate among various operating systems.</i>	✓	✓	✓	✓			✓	✓	✓	
3	<i>Explain the process of authentication and authorization between end-user devices and network resources.</i>		✓	✓				✓	✓	✓	
4	<i>Identify a variety of assistive or adaptive technologies and universal design considerations.</i>					✓	✓			✓	
5	<i>Identify basic components of an end-user IT system.</i>	✓	✓	✓	✓	✓		✓	✓	✓	
6	<i>Implement a hardware and software configuration responsive to an identified scenario.</i>	✓	✓	✓	✓	✓	✓			✓	
7	<i>Summarize life-cycle strategies for replacement, reuse, recycling IT technology and resources.</i>						✓			✓	
8	<i>Summarize strategies to support or train users</i>						✓			✓	

	<i>with their IT resources.</i>										
	Learning Outcome	CGS 1060C	CTS 1133C	CTS 2131C	CIS 1000C	COP 1334C	CIS 1513C	CET 2472C	CTS 2120C	CGS 1557C	CGS 1540C
9	<i>Use a variety of practices for making end-user systems secure.</i>		✓	✓				✓	✓	✓	
10	<i>Describe the data management activities associated with the data lifecycle.</i>						✓			✓	✓
11	<i>Diagram a database design based on an identified scenario.</i>						✓			✓	✓
12	<i>Differentiate between public and private data.</i>									✓	✓
13	<i>Discuss applications of data analytics.</i>						✓			✓	
14	<i>Discuss issues relevant to dealing with very large data sets, both structured and unstructured.</i>						✓			✓	✓
15	<i>Identify database administration tasks.</i>									✓	✓
16	<i>Produce simple database queries.</i>									✓	✓
17	<i>Use data analytics to support decision making for a given scenario.</i>						✓			✓	✓
18	<i>Differentiate among a variety of technology-based sensory interactions.</i>		✓	✓	✓			✓	✓	✓	
19	<i>Differentiate among data types, data transfer protocols and file characteristics specific to the targeted use.</i>						✓	✓		✓	
20	<i>Illustrate the activities of a digital media design process.</i>									✓	
21	<i>Implement communication principles into digital media design.</i>									✓	
22	<i>Carry out basic computer network troubleshooting techniques.</i>		✓	✓				✓	✓	✓	
23	<i>Describe the layers, protocols and components of the OSI model.</i>							✓	✓	✓	
24	<i>Diagram the components of an IT integrated system.</i>							✓	✓	✓	

	Learning Outcome	CGS 1060C	CTS 1133C	CTS 2131C	CIS 1000C	COP 1334C	CIS 1513C	CET 2472C	CTS 2120C	CGS 1557C	CGS 1540C
25	<i>Differentiate among various computer networking models.</i>							✓	✓	✓	
26	<i>Differentiate among various techniques for making a computer network secure.</i>							✓	✓	✓	
27	<i>Summarize the flow of data through a computer network scenario.</i>							✓	✓	✓	
28	<i>Demonstrate best practices for designing end-user computing interfaces.</i>					✓	✓			✓	✓
29	<i>Demonstrate the techniques of defensive programming and secure coding.</i>					✓				✓	
30	<i>Diagram the phases of the Secure Software Development Lifecycle.</i>					✓				✓	
31	<i>Discuss software development methodologies.</i>				✓	✓				✓	
32	<i>Summarize the differences among various programming languages.</i>				✓	✓		✓	✓	✓	
33	<i>Use a programming or a scripting language to share data across an integrated IT system.</i>					✓				✓	
34	<i>Use a programming or a scripting language to solve a problem.</i>					✓				✓	
35	<i>Differentiate among strategies for business continuity provisioning of IT resources at the enterprise level.</i>				✓			✓	✓	✓	
36	<i>Discuss data governance and its implications for users as well as IT professionals.</i>				✓			✓	✓	✓	
37	<i>Identify a variety of enterprise-level digital storage technologies.</i>				✓			✓	✓	✓	
38	<i>Implement an application of virtualization.</i>							✓	✓	✓	
39	<i>Modify a system to improve data confidentiality or regulatory compliance.</i>							✓	✓	✓	
40	<i>Summarize the implications of various cloud computing models.</i>							✓	✓	✓	

	Learning Outcome	CGS 1060C	CTS 1133C	CTS 2131C	CIS 1000C	COP 1334C	CIS 1513C	CET 2472C	CTS 2120C	CGS 1557C	CGS 1540C
41	<i>Summarize the security implications and risks for distributed IT systems.</i>							✓	✓	✓	✓
42	<i>Use communication, negotiation, and collaboration skills as a member of a diverse team.</i>	✓			✓		✓	✓	✓	✓	✓
43	<i>Describe the attitudes, knowledge and abilities associated with quality customer service.</i>				✓	✓	✓	✓	✓	✓	
44	<i>Produce technical documentation responsive to an identified computing scenario.</i>				✓	✓		✓	✓	✓	✓
45	<i>Use documentation or a knowledge base to resolve a technical challenge in an identified computing scenario.</i>				✓	✓		✓	✓	✓	✓
46	<i>Discuss significant trends and emerging technologies and their impact on our global society.</i>	✓			✓	✓	✓	✓	✓	✓	
47	<i>Demonstrate professional behavior in response to an ethically-challenging scenario in computing.</i>				✓		✓		✓	✓	
48	<i>Summarize the tenets of ethics and professional behavior promoted by international computing societies.</i>				✓		✓			✓	
49	<i>Describe IT procurement processes for goods and services.</i>				✓		✓	✓	✓	✓	✓
50	<i>Summarize the role of IT in supporting the mission and goals of an organization.</i>	✓			✓	✓	✓			✓	✓

Institution Name: Estrella Mountain Community College, Phoenix, AZ
Institution URL: www.estrellamountain.edu
Contact Name: Prof. Jim Nichols, Division Chair
Program Title: Linux Professional
Program Type: Certificate of Completion
Program URL: <https://aztransmac2.asu.edu/cgi-bin/WebObjects/acres.woa/wa/freeForm?id=46091>
Course Descriptions:

1. **CIS126DL: Linux Operating System** - Introduction to the Linux Operating system. Develop knowledge and skills required to install, configure and troubleshoot a Linux-based workstation including basic network functions. Learn basic command line and Graphical User Interface (GUI) desktop environment utilities and applications. Fundamental abilities to achieve the entry-level industry certification covered.
2. **CIS238DL: Linux System Administration** - Managing Linux Operating Systems including sophisticated manipulation of file structures, backup systems, printing processes, troubleshooting, user account management, hard disk maintenance and configuration, process monitoring and prioritizing, kernel customization, and system resource control. Preparation for industry certifications such as the SAIR/GNU LCP and LCA certificates, CompTIA's Linux+, RHCT, RHCE, and LPIC.

Table 6: Estrella Mountain Community College Certificate Correlation

	<i>Learning Outcome</i>	CIS 126DL	CIS 238DL
1	<i>Carry out trouble-shooting strategies for resolving an identified end-user IT problem.</i>	✓	✓
2	<i>Differentiate among various operating systems.</i>	✓	
3	<i>Explain the process of authentication and authorization between end-user devices and network resources.</i>	✓	✓
4	<i>Identify a variety of assistive or adaptive technologies and universal design considerations.</i>		
5	<i>Identify basic components of an end-user IT system.</i>	✓	✓
6	<i>Implement a hardware and software configuration responsive to an identified scenario.</i>	✓	✓

	Learning Outcome	CIS 126DL	CIS 238DL
7	<i>Summarize life-cycle strategies for replacement, reuse, recycling IT technology and resources.</i>		
8	<i>Summarize strategies to support or train users with their IT resources.</i>		
9	<i>Use a variety of practices for making end-user systems secure.</i>	✓	✓
10	<i>Describe the data management activities associated with the data lifecycle.</i>		
11	<i>Diagram a database design based on an identified scenario.</i>		
12	<i>Differentiate between public and private data.</i>		
13	<i>Discuss applications of data analytics.</i>		
14	<i>Discuss issues relevant to dealing with very large data sets, both structured and unstructured.</i>		
15	<i>Identify database administration tasks.</i>		
16	<i>Produce simple database queries.</i>		
17	<i>Use data analytics to support decision making for a given scenario.</i>		
18	<i>Differentiate among a variety of technology-based sensory interactions.</i>		
19	<i>Differentiate among data types, data transfer protocols and file characteristics specific to the targeted use.</i>	✓	
20	<i>Illustrate the activities of a digital media design process.</i>		
21	<i>Implement communication principles into digital media design.</i>		
22	<i>Carry out basic computer network troubleshooting techniques.</i>		

	Learning Outcome	CIS 126DL	CIS 238DL
23	<i>Describe the layers, protocols and components of the OSI model.</i>		
24	<i>Diagram the components of an integrated IT system.</i>		
25	<i>Differentiate among various computer networking models.</i>		
26	<i>Differentiate among various techniques for making a computer network secure.</i>	✓	✓
27	<i>Summarize the flow of data through a computer network scenario.</i>		
28	<i>Demonstrate best practices for designing end-user computing interfaces.</i>		
29	<i>Demonstrate the techniques of defensive programming and secure coding.</i>		
30	<i>Diagram the phases of the Secure Software Development Lifecycle.</i>		
31	<i>Discuss software development methodologies.</i>		
32	<i>Summarize the differences among various programming languages.</i>		
33	<i>Use a programming or a scripting language to share data across an integrated IT system.</i>		
34	<i>Use a programming or a scripting language to solve a problem.</i>	✓	
35	<i>Differentiate among strategies for business continuity provisioning of IT resources at the enterprise level.</i>		✓
36	<i>Discuss data governance and its implications for users as well as IT professionals.</i>		
37	<i>Identify a variety of enterprise-level digital storage technologies.</i>		✓
38	<i>Implement an application of virtualization.</i>		

	Learning Outcome	CIS 126DL	CIS 238DL
39	<i>Modify a system to improve data confidentiality or regulatory compliance.</i>		✓
40	<i>Summarize the implications of various cloud computing models.</i>		
41	<i>Summarize the security implications and risks for distributed IT systems.</i>		✓
42	<i>Use communication, negotiation, and collaboration skills as a member of a diverse team.</i>		
43	<i>Describe the attitudes, knowledge and abilities associated with quality customer service.</i>		
44	<i>Produce technical documentation responsive to an identified computing scenario.</i>		
45	<i>Use documentation or a knowledge base to resolve a technical challenge in an identified computing scenario.</i>	✓	
46	<i>Discuss significant trends and emerging technologies and their impact on our global society.</i>	✓	
47	<i>Demonstrate professional behavior in response to an ethically-challenging scenario in computing.</i>		
48	<i>Summarize the tenets of ethics and professional behavior promoted by international computing societies.</i>		
49	<i>Describe IT procurement processes for goods and services.</i>		
50	<i>Summarize the role of IT in supporting the mission and goals of an organization.</i>		

Institution Name: Kapi'olani Community College, Honolulu, HI
Institution URL: www.kapiolani.hawaii.edu
Contact Name: Prof. Steven A. Singer, Ed.D.
Program Title: Information Technology
Program Type: Associate in Science (A.S.)
Program URL: <http://blt.kapiolani.hawaii.edu/information-technology-program-description/>
Course Descriptions:

1. **ICS 101: Digital Tools for the Information World** - ICS 101 provides hands-on computer instruction with an emphasis on producing professional-level documents, spreadsheets, presentations, databases, and Web pages for problem solving. This course includes concepts, terminology, and a contemporary operating system.
2. **ITS 124: Small Business Networking**- ITS 124 provides students with an overview of essential networking concepts, terminology and skills. The course gives students a fundamental understanding of the technological, business and legal issues related to a networked organization. The course also introduces the student to security concepts, such as cryptography, digital signatures, key management and authentication. Some students may opt to take the CompTIA Network+ exam upon the completion of ITS 124 because much of the CompTIA Network+ exam material is covered in class.
3. **ITS 128: Introduction to Problems Solving and the Programming Process** - ITS 128 introduces students to the development of problem solving, logical and programming skills used in a business computing environment. Step-by-step logic is diagrammed into flowcharts and implemented in computer programs in a language deemed most appropriate for this course. Emphases are placed on valid solution designs and correct language syntax usage. Basic programming structures and concepts, common to all programming languages, are major components of this course.
4. **ITS 129: Introduction to Databases** - ITS 129 is an introduction to databases. The course covers the tools needed to query and modify database objects. The course also introduces the student to database design concepts. A substantial part of the course involves the understanding of the relationship between databases, tables, records and fields. The course includes hands-on use in a computer environment that provides the students with experience designing, creating, and manipulating a database using the appropriate information technology tools.
5. **ITS 144: Business PC System Maintenance, Support and OS Installation** - ITS 144 provides PC operating system and hardware concepts and hands-on activities relating to the following topics: PC computer architecture, operating system theory, current PC operating systems, hard drive formatting and operating system installation and upgrading, peripheral device drivers, network connectivity, resource sharing over a network, construction, installation, upgrading, troubleshooting, and maintenance of hardware and software components of microcomputer systems. Course will cover specification, selection, installation and configuration of hardware components including memory, floppy disk drives, microprocessors, hard drives, DVDs/CDs and DVD/CD-writers, video cards, NIC cards, sound cards, monitors and printers as related to a business environment.
6. **ITS 148: Visual Studio I** - ITS 148 is an introductory course in using the Visual Studio Integrated Development Environment (IDE) to provide viable computing solutions in a business environment. It is assumed that the student is familiar with computer programming. Applications with

forms, controls, and code are developed in Visual Studio, using one of its programming languages deemed most appropriate for the course. Computer applications are executed, debugged, and undergo tests of their validity. Introductory object oriented programming concepts are emphasized and realized through the creation of user defined classes and their properties and methods. Data validation and general procedure development are also components of this course.

7. **ITS 149AD: Database Administration I** - ITS 149AD is designed to give students a firm foundation in basic database administration. In this class, students learn how to install and maintain a database server. They will gain a conceptual understanding of database server architecture and how its components work and interact with one another. They will also learn how to create an operational database and properly manage the various structures in an effective and efficient manner including performance monitoring, database security, user management, and backup/recovery techniques.
8. **ITS 224: Help Desk Support Practices** - T ITS 224 introduces the Information Technology student to the key concepts and skills of Help Desk operation. Students will study what a Help Desk is, characteristics of its users, common problems, and tools. Students will learn about how a Help Desk fits into an organization's structure and mission. Students will learn about the protocol and processing of incidents, and the different support levels and methods. Students will learn about knowledge, asset and security management and how important these are to an organization's integrity. Students will have opportunities to both study and practice Help Desk operations in a controlled setting.
9. **ITS 227: Website Development** - ITS 227 introduces the student to the Internet and its effects on modern society. Students will review its history, concepts, and terminology. Hands-on activities will include how to connect to and navigate the Internet, create World Wide Web pages, and develop World Wide Web sites. A variety of Internet resources will be demonstrated and subsequently explored by students.
10. **ITS 228: Visual Studio Programming** - ITS 228 is an advanced-intermediate course in using the Visual Studio Integrated Development Environment (IDE) to provide viable computing solutions in a business environment. It is assumed that the student is familiar with Visual Studio. Enhanced user interfaces, especially those used in multi-form applications are covered. Also included in this course are the development and processing of XML documents. Object oriented programming concepts regarding inheritance are emphasized and realized through the creation of user defined derived classes that overload and override base classes. Database application development is also a component of this course.
11. **ITS 229AD: Database Administration II** - ITS 229AD advances students' knowledge of database administration. In this class, students will learn how to configure a database server for multilingual applications. Students will practice various methods of recovering the database using RMAN and Flashback technology. Database performance monitoring tools will be covered, in addition to the steps to take to resolve common problems and improve performance. Students will also learn how to administer a database efficiently by using database technologies such as the Resource Manager, the Scheduler, Automatic Storage Management (ASM), and VLDB features. Students will set up a secure database using Virtual Private Database, and learn how to efficiently move data from database to database.
12. **ITS 293: Information Technology Program Internship** - ITS 293 is a cooperative internship education course involving the student and an employer or the college that integrates classroom learning with supervised, structured practical experience. Students' interests, ITS program content and the availability of jobs are considered when making practicum assignments. It offers the opportunity to develop workplace soft skills as well as technical skill.

Table 7: Kapi’olani Community College Program Correlation

	Learning Outcome	ICS 101	ITS 124	ITS 128	ITS 129	ITS 144	ITS 148	ITS 149AD	ITS 224	ITS 227	ITS 228	ITS 229AD	ITS 293
1	<i>Carry out trouble-shooting strategies for resolving an identified end-user IT problem.</i>		✓			✓			✓				
2	<i>Differentiate among various operating systems.</i>	✓				✓			✓				
3	<i>Explain the process of authentication and authorization between end-user devices and network resources.</i>		✓										
4	<i>Identify a variety of assistive or adaptive technologies and universal design considerations.</i>	✓											
5	<i>Identify basic components of an end-user IT system.</i>	✓											
6	<i>Implement a hardware and software configuration responsive to an identified scenario.</i>					✓			✓				
7	<i>Summarize life-cycle strategies for replacement, reuse, recycling IT technology and resources.</i>					✓							
8	<i>Summarize strategies to support or train users with their IT resources.</i>								✓				
9	<i>Use a variety of practices for making end-user systems secure.</i>					✓			✓				
10	<i>Describe the data management activities associated with the data lifecycle.</i>							✓					
11	<i>Diagram a database design based on an identified scenario.</i>				✓								
12	<i>Differentiate between public and private data.</i>							✓				✓	
13	<i>Discuss applications of data analytics.</i>											✓	
14	<i>Discuss issues relevant to dealing with very large data sets, both structured and unstructured.</i>											✓	
15	<i>Identify database administration tasks.</i>							✓				✓	

	Learning Outcome	ICS 101	ITS 124	ITS 128	ITS 129	ITS 144	ITS 148	ITS 149AD	ITS 224	ITS 227	ITS 228	ITS 229AD	ITS 293
16	<i>Produce simple database queries.</i>				✓								
17	<i>Use data analytics to support decision making for a given scenario.</i>							✓					
18	<i>Differentiate among a variety of technology-based sensory interactions.</i>	✓											
19	<i>Differentiate among data types, data transfer protocols and file characteristics specific to the targeted use.</i>				✓					✓			
20	<i>Illustrate the activities of a digital media design process.</i>												
21	<i>Implement communication principles into digital media design.</i>												
22	<i>Carry out basic computer network troubleshooting techniques.</i>		✓										
23	<i>Describe the layers, protocols and components of the OSI model.</i>		✓										
24	<i>Diagram the components of an IT integrated system.</i>		✓										
25	<i>Differentiate among various computer networking models.</i>		✓										
26	<i>Differentiate among various techniques for making a computer network secure.</i>		✓										
27	<i>Summarize the flow of data through a computer network scenario.</i>		✓										
28	<i>Demonstrate best practices for designing end-user computing interfaces.</i>									✓			
29	<i>Demonstrate the techniques of defensive programming and secure coding.</i>						✓						
30	<i>Diagram the phases of the Secure Software Development Lifecycle.</i>												
31	<i>Discuss software development methodologies.</i>						✓						

	Learning Outcome	ICS 101	ITS 124	ITS 128	ITS 129	ITS 144	ITS 148	ITS 149AD	ITS 224	ITS 227	ITS 228	ITS 229AD	ITS 293
32	<i>Summarize the differences among various programming languages.</i>			✓									
33	<i>Use a programming or a scripting language to share data across an integrated IT system.</i>									✓	✓		
34	<i>Use a programming or a scripting language to solve a problem.</i>									✓	✓		
35	<i>Differentiate among strategies for business continuity provisioning of IT resources at the enterprise level.</i>												
36	<i>Discuss data governance and its implications for users as well as IT professionals.</i>												
37	<i>Identify a variety of enterprise-level digital storage technologies.</i>												
38	<i>Implement an application of virtualization.</i>							✓			✓		
39	<i>Modify a system to improve data confidentiality or regulatory compliance.</i>												
40	<i>Summarize the implications of various cloud computing models.</i>												
41	<i>Summarize the security implications and risks for distributed IT systems.</i>												
42	<i>Use communication, negotiation, and collaboration skills as a member of a diverse team.</i>									✓			
43	<i>Describe the attitudes, knowledge and abilities associated with quality customer service.</i>								✓				
44	<i>Produce technical documentation responsive to an identified computing scenario.</i>								✓	✓			
45	<i>Use documentation or a knowledge base to resolve a technical challenge in an identified computing scenario.</i>								✓	✓			
46	<i>Discuss significant trends and emerging technologies and their impact on our global</i>									✓			

	<i>society.</i>												
	Learning Outcome	ICS 101	ITS 124	ITS 128	ITS 129	ITS 144	ITS 148	ITS 149AD	ITS 224	ITS 227	ITS 228	ITS 229AD	ITS 293
47	<i>Demonstrate professional behavior in response to an ethically-challenging scenario in computing.</i>									✓			✓
48	<i>Describe IT procurement processes for goods and services.</i>									✓			
49	<i>Summarize the role of IT in supporting the mission and goals of an organization.</i>												
50	<i>Summarize the tenets of ethics and professional behavior promoted by international computing societies.</i>									✓			✓

Institution Name: Manor College, Jenkintown, PA
Institution URL: www.manor.edu
Contact Name: Prof. Norma E. Hall, Director IST Program
Program Title: Information Systems and Technology with three tracks: 1) Transfer, 2) Design Technology, and 3) Networking
Program Type: Associate in Science (A.S.)
Program URL: <http://manor.edu/academics/degrees/ist.php>
Course Descriptions:

1. **IST 105: Introduction to Microcomputer Applications** - Laboratory course to provide students with proficiency in Windows and the applications of word processing, spreadsheet, presentation and database management functions. Class exercises will focus on business situations and instructional software packages reflecting current business usage. The Internet will also be covered, with topics including use of an Internet browser, e-mail, and using the Web. An exemption test is available for this course.
2. **IST 106: Introduction to Computer Technology and Programming Logic** - This course will present students with basic concepts and terminology for computer hardware; software; networks; the Internet; mobile devices such as cell phones, PDAs and laptops. Hands-on exercises will expose students to Microsoft Office applications (Word, Excel, PowerPoint, and Access). Course will explore use of Internet for research and how to evaluate web sources. Students will also learn computational thinking and explore object-oriented programming concepts and techniques as they create movies and interactive games using ALICE software. Ethical issues will be discussed throughout the course.
3. **IST 181: Operating and Application Systems** - Learn functions and major components of systems software, and identify and define the important features of current operating systems. Install an operating system. Use OS for data and file management, backup, hard-drive maintenance functions, etc. Be familiar with general utility programs. Demonstrate familiarity with both stand-alone and network operating systems. Create, use and maintain system configuration. Change configuration parameters to optimize performance. Describe major features and functions of major categories of applications software (word processing, spreadsheet, database, browsers, e-mail, etc.). Use basic features of office productivity software. Demonstrate ability to learn a new feature in software package, and ability to learn a known application (such as word processing) in another vendor's package. Install and test an application software package. (Elective)
4. **IST 203: Computer Graphics** - Design and compose computer graphics in the first half of the semester, and then produce and publish those graphics in both print and web formats. Computer animation will also be introduced. Course will focus on theory and technique, using currently popular graphic and publishing software. Prerequisite: IST 105 or IST 106. (Elective)
5. **IST 205: Management Information Systems** - This course explores current information management techniques. The system development life cycle is reviewed from initial needs analysis to final testing and implementation. Topics include benefit/cost analysis, data flow diagrams, top-down design, techniques for planning program development (including modular coding, implementation, and maintenance.) Various types of programming will be reviewed, including Third and Fourth Generation Languages, Object-Oriented Programming, and CASE tools. Prerequisite: IST 105 or passing grade on exemption test and BA 101.
6. **IST 206: Computer Forensics** - Based on the objectives of the International Association of Computer Investigative Specialists (IACIS) certification, this course prepares students to understand computer investigations and current computer forensic tools. Various components of

digital investigation and presentation of evidence as an expert witness will be explored. Application of these concepts for network security and control will be explored. Prerequisite: IST 105 or IST 106. (Elective)

7. **IST 210: Programming I** - An introductory contemporary computer programming language course to overview basic structured programming concepts, and provide students with the ability to write simple programs. Course will consist of lectures and hands-on exercises, with projects assigned to be completed using the Manor Student Network. Prerequisite: IST 106. (Elective)
8. **IST 211: Programming II** - Detailed course in problem solving, expanding upon programming language skills acquired in IST 210. This course emphasizes concepts of system design, coding, testing and implementation and introduces object oriented programming concepts. Course will involve extensive coding using structured programming techniques. Prerequisite: IST 210. (Elective)
9. **IST 212: Visual Basic Programming** - Visual Basic will be used to create applications for the Windows operating system. Students will learn how to work with pre-built objects, graphics, enter commands, use variables and constants, use programming control structures and work with classes. The course will include an introduction to Active X DataObjects and functions of the API. Prerequisite: IST 106. (Elective)
10. **IST 215: Database Management and Design** - Concepts, procedures, design, implementation and management issues of database systems, following database development life cycle. Stresses importance of needs analysis, requirements statement, and testing final product against initial requirements definition. Database management and security issues will be explored. Programming will be based on currently used business application database software, and SQL. Theory will be reinforced with projects to be completed using database software on the Manor Student Network. Prerequisite: IST 105 and IST 205.
11. **IST 217: Web Page Design and Development** - This course introduces students to the fundamentals of World Wide Web home page design using the Hypertext Markup Language (HTML) and a simple HTML editor. Students will gain extensive hands-on experience creating Web pages using HTML tags for links, tables, forms, and images. Additionally, the course will present an introduction to basic web page scripting and web database interfacing. Web publishing software such as Microsoft Front Page will also be explored. Quality design elements and style will be considered throughout the course. Prerequisite: IST 105 or IST 106. (Elective)
12. **IST 218: Computer Networks** - An overview of computer communications, hardware and software requirements, protocols and applications, including terminal emulation, remote login and file transfer. Explore local area network topologies, installation and administration issues. Prerequisite: IST 105 or IST 106.
13. **IST 219: Data Structures and Algorithms** - Course provides an overview of data structures, including arrays, lists, stacks, queues, classes and trees. Abstract data types (ADTs) are also covered. Other topics included are: recursion, linked-lists, Big-O notation, linear and binary searches, hashing and sorting. Prerequisite: IST 210. (Elective)
14. **IST 299: Information Systems and Technology Internship** - Students complete a minimum of 80 hours of computer-related work experience. Job functions can include programming, user support, network support and administration, web site development or other related responsibilities (subject to approval by the program director). Students are responsible for placement search, interviewing, and transportation to and from the work site. Students will be required to keep a journal of their hours, and employer feedback will impact student's course grade. There will be six (6) sessions with the course instructor to discuss various work-related topics, including appropriate work dress and ethics, working in teams, managing your manager, how to deal with stress, etc. Prerequisite: Students must have successfully completed (C or better) at least nine credits in IST courses. (Elective)

Table 8: Manor College Program Correlation

	Learning Outcome	IST 105	IST 106	IST 205	IST 215	IST 218	IST 181	IST 203	IST 206	IST 210	IST 211	IST 212	IST 217	IST 219	IST 299
1	<i>Carry out trouble-shooting strategies for resolving an identified end-user IT problem.</i>	✓			✓	✓	✓			✓	✓	✓			
2	<i>Differentiate among various operating systems.</i>					✓	✓								
3	<i>Explain the process of authentication and authorization between end-user devices and network resources.</i>					✓									
4	<i>Identify a variety of assistive or adaptive technologies and universal design considerations.</i>			✓											
5	<i>Identify basic components of an end-user IT system.</i>	✓				✓									
6	<i>Implement a hardware and software configuration responsive to an identified scenario.</i>			✓		✓	✓								
7	<i>Summarize life-cycle strategies for replacement, reuse, recycling IT technology and resources.</i>			✓		✓									
8	<i>Summarize strategies to support or train users with their IT resources.</i>			✓	✓	✓									
9	<i>Use a variety of practices for making end-user systems secure.</i>			✓		✓	✓		✓				✓		
10	<i>Describe the data management activities associated with the data lifecycle.</i>			✓	✓										
11	<i>Diagram a database design based on an identified scenario.</i>			✓	✓										
12	<i>Differentiate between public and private data.</i>			✓	✓										
13	<i>Discuss applications of data analytics.</i>			✓	✓										
14	<i>Discuss issues relevant to dealing with very large data sets, both structured and unstructured.</i>				✓										
15	<i>Identify database administration tasks.</i>			✓	✓										

	Learning Outcome	IST 105	IST 106	IST 205	IST 215	IST 218	IST 181	IST 203	IST 206	IST 210	IST 211	IST 212	IST 217	IST 219	IST 299
16	<i>Produce simple database queries.</i>	✓	✓	✓	✓										
17	<i>Use data analytics to support decision making for a given scenario.</i>	✓		✓	✓										
18	<i>Differentiate among a variety of technology-based sensory interactions.</i>	✓	✓	✓		✓		✓					✓		
19	<i>Differentiate among data types, data transfer protocols and file characteristics specific to the targeted use.</i>			✓	✓	✓				✓	✓	✓	✓	✓	
20	<i>Illustrate the activities of a digital media design process.</i>	✓	✓					✓					✓		
21	<i>Implement communication principles into digital media design.</i>	✓	✓					✓					✓		
22	<i>Carry out basic computer network troubleshooting techniques.</i>					✓									
23	<i>Describe the layers, protocols and components of the OSI model.</i>					✓									
24	<i>Diagram the components of an IT integrated system.</i>					✓									
25	<i>Differentiate among various computer networking models.</i>					✓									
26	<i>Differentiate among various techniques for making a computer network secure.</i>					✓									
27	<i>Summarize the flow of data through a computer network scenario.</i>					✓									
28	<i>Demonstrate best practices for designing end-user computing interfaces.</i>		✓							✓	✓	✓			
29	<i>Demonstrate the techniques of defensive programming and secure coding.</i>		✓	✓						✓	✓	✓		✓	
30	<i>Diagram the phases of the Secure Software Development Lifecycle.</i>		✓	✓						✓	✓	✓		✓	
31	<i>Discuss software development methodologies.</i>		✓	✓						✓	✓	✓		✓	

	Learning Outcome	IST 105	IST 106	IST 205	IST 215	IST 218	IST 181	IST 203	IST 206	IST 210	IST 211	IST 212	IST 217	IST 219	IST 299
32	<i>Summarize the differences among various programming languages.</i>		✓	✓						✓	✓	✓		✓	
33	<i>Use a programming or a scripting language to share data across an integrated IT system.</i>	✓		✓								✓			
34	<i>Use a programming or a scripting language to solve a problem.</i>		✓		✓					✓	✓	✓			
35	<i>Differentiate among strategies for business continuity provisioning of IT resources at the enterprise level.</i>			✓	✓	✓									
36	<i>Discuss data governance and its implications for users as well as IT professionals.</i>			✓	✓										
37	<i>Identify a variety of enterprise-level digital storage technologies.</i>				✓	✓									
38	<i>Implement an application of virtualization.</i>			✓		✓									
39	<i>Modify a system to improve data confidentiality or regulatory compliance.</i>			✓	✓										
40	<i>Summarize the implications of various cloud computing models.</i>			✓		✓									
41	<i>Summarize the security implications and risks for distributed IT systems.</i>			✓	✓	✓									
42	<i>Use communication, negotiation, and collaboration skills as a member of a diverse team.</i>			✓		✓						✓			
43	<i>Describe the attitudes, knowledge and abilities associated with quality customer service.</i>			✓	✓	✓	✓					✓			
44	<i>Produce technical documentation responsive to an identified computing scenario.</i>	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	
45	<i>Use documentation or a knowledge base to resolve a technical challenge in an identified computing scenario.</i>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
46	<i>Discuss significant trends and emerging technologies and their impact on our global</i>	✓		✓	✓	✓	✓								

	<i>society.</i>														
	Learning Outcome	IST 105	IST 106	IST 205	IST 215	IST 218	IST 181	IST 203	IST 206	IST 210	IST 211	IST 212	IST 217	IST 219	IST 299
47	<i>Demonstrate professional behavior in response to an ethically-challenging scenario in computing.</i>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
48	<i>Summarize the tenets of ethics and professional behavior promoted by international computing societies.</i>			✓	✓	✓				✓	✓	✓			✓
49	<i>Describe IT procurement processes for goods and services.</i>			✓		✓									
50	<i>Summarize the role of IT in supporting the mission and goals of an organization.</i>			✓	✓	✓									✓

Institution Name: North Seattle College, Seattle, WA
Institution URL: www.northseattle.edu
Contact Name: Prof. Michelle Melero, Program Manager
Program Title: Application Development
Program Type: Bachelor of Applied Science (B.A.S.)
Program URL: www.northseattle.edu/bas-app-development
Program Notes: The Application Development B.A.S. degree currently accepts students with an A.A. or A.A.S. degree in any field. North Seattle College currently offers one IT A.A.S. degree, *Programming & IT Network Support* that feeds directly into the B.A.S. degree. Seattle Central (community) College within the district offers an Information Technology programming certificate and an A.A.S. degree, which both directly feed into the B.A.S. degree.

Course Descriptions:

1. **AD 300: Component Software** - This course focuses on object-oriented programming using Java with an emphasis in the creation and use of software components. It also presents other programming concepts such as reusability, the model-view-controller (MVC) design pattern, elementary data structures (linked lists, binary trees), recursion, and algorithmic analysis using Big-O notation. Prerequisite: Program entry. (5 credits)
2. **AD 310: Software Lifecycle** - An overview of tools, processes and practical approaches that support a software product's life cycle, from inception to obsolescence. Topics include: software project life-cycle management; team member roles; defining target customers; project tasks and timelines; responding to changing project requirements; dealing with limited time and resources; development paradigms such as waterfall and agile; quality documentation; and tools for source code management, automated unit testing and debugging. The course also covers legal and ethical issues as they relate to any part of the software product's life cycle; such as legal and ethical impacts of software failures; functionality and expandability limitations; and licensing and support agreements. Prerequisite: Program entry. (5 credits)
3. **AD 325: Data Structures and Algorithms** - Covers fundamental data structures and their algorithms and applications in problem solving by programming. Includes linked lists, stacks, queues, priority queues, binary and multi-way trees, directed graphs, hashing, and internal and external sorting. Prerequisite: AD 300 Component Software. (5 credits)
4. **AD 330: Professional Communication in IT** - This course presents strategies for effective communication in professional settings with an emphasis on the technology environment. Students apply best practices in formal and informal situations, for in-person and virtual communication. Best practices to support effective development team collaboration are examined and discussed in the context of various case studies. Students apply communication styles to specific situations and audiences. The course also examines technical and professional communication in light of the ethical considerations, as well as the intersection with legal issues, such as copyright fair use, and intellectual property. Prerequisite: Program entry. (5 credits)
5. **AD 350: Relational Database Technology** - Covers intermediate programming in a relational database. Provides an introduction to non-relational databases as used in Cloud Computing and Big Data. The RDMS topics include stored procedures, triggers, indexing and abstraction

techniques, query construct efficiency. Compare and contrast RDMS to noSQL databases: uses, terminology, indexing, storage, compute consumption, ROI, reliability. Prerequisite: Program entry. (5 credits)

6. **AD 400: Project Management in Software Development** - This course provides a comprehensive overview of current processes, practices and tools used to manage software development projects. Using a combination of industry-relevant case studies and projects, students learn and apply best practices for planning, organizing, scheduling, and controlling software projects, and how to adapt strategies to specific project needs and constraints. Topics also include requirement identification and analysis, project documentation, and legal and licensing requirements. The course emphasizes legal and ethical issues that relate to all aspects of project management; such as issues relating to contractual agreements and licensing, resource acquisition and management, testing and deliverables, and customer support and management. Prerequisite: Completed at least one practicum. (5 credits)
7. **AD 420: Cloud Computing-Software as a Service** - This course introduces students to the fundamentals of cloud computing, both in terms of software as a service (SaaS) and infrastructure as a service (IaaS). Students learn tools and strategies to build Web applications based on cloud services, integrate third party APIs and integrate big data tools such as predictive analytics. Students explore legal and ethical issues that are specific to the cloud computing environment, such as security, integrity and privacy of data; and continuity of service. Prerequisite: Web Apps and Data Structures. (5 credits)

Table 9: North Seattle College Program Correlation

	Learning Outcome	AD 300	AD 310	AD 325	AD 330	AD 350	AD 400	AD 420
1	<i>Carry out trouble-shooting strategies for resolving an identified end-user IT problem.</i>							
2	<i>Differentiate among various operating systems.</i>							
3	<i>Explain the process of authentication and authorization between end-user devices and network resources.</i>							
4	<i>Identify a variety of assistive or adaptive technologies and universal design considerations.</i>						✓	
5	<i>Identify basic components of an end-user IT system.</i>							
6	<i>Implement a hardware and software configuration responsive to an identified scenario.</i>	✓						
7	<i>Summarize life-cycle strategies for replacement, reuse, recycling IT technology and resources.</i>		✓					

	Learning Outcome	AD 300	AD 310	AD 325	AD 330	AD 350	AD 400	AD 420
8	<i>Summarize strategies to support or train users with their IT resources.</i>							
9	<i>Use a variety of practices for making end-user systems secure.</i>							
10	<i>Describe the data management activities associated with the data lifecycle.</i>		✓					
11	<i>Diagram a database design based on an identified scenario.</i>					✓		
12	<i>Differentiate between public and private data.</i>							
13	<i>Discuss applications of data analytics.</i>							✓
14	<i>Discuss issues relevant to dealing with very large data sets, both structured and unstructured.</i>							
15	<i>Identify database administration tasks.</i>							
16	<i>Produce simple database queries.</i>					✓		
17	<i>Use data analytics to support decision making for a given scenario.</i>					✓		
18	<i>Differentiate among a variety of technology-based sensory interactions.</i>							
19	<i>Differentiate among data types, data transfer protocols and file characteristics specific to the targeted use.</i>							
20	<i>Illustrate the activities of a digital media design process.</i>							
21	<i>Implement communication principles into digital media design.</i>				✓			
22	<i>Carry out basic computer network troubleshooting techniques.</i>							
23	<i>Describe the layers, protocols and components of the OSI model.</i>					✓		

	Learning Outcome	AD 300	AD 310	AD 325	AD 330	AD 350	AD 400	AD 420
24	<i>Diagram the components of an IT integrated system.</i>							
25	<i>Differentiate among various computer networking models.</i>							
26	<i>Differentiate among various techniques for making a computer network secure.</i>							
27	<i>Summarize the flow of data through a computer network scenario.</i>							
28	<i>Demonstrate best practices for designing end-user computing interfaces.</i>						✓	
29	<i>Demonstrate the techniques of defensive programming and secure coding.</i>	✓						
30	<i>Diagram the phases of the Secure Software Development Lifecycle.</i>		✓					
31	<i>Discuss software development methodologies.</i>							
32	<i>Summarize the differences among various programming languages.</i>			✓				
33	<i>Use a programming or a scripting language to share data across an integrated IT system.</i>	✓						
34	<i>Use a programming or a scripting language to solve a problem.</i>	✓		✓				
35	<i>Differentiate among strategies for business continuity provisioning of IT resources at the enterprise level.</i>							
36	<i>Discuss data governance and its implications for users as well as IT professionals.</i>							
37	<i>Identify a variety of enterprise-level digital storage technologies.</i>							
38	<i>Implement an application of virtualization.</i>							
39	<i>Modify a system to improve data confidentiality or regulatory compliance.</i>							

	Learning Outcome	AD 300	AD 310	AD 325	AD 330	AD 350	AD 400	AD 420
40	<i>Summarize the implications of various cloud computing models.</i>					✓		✓
41	<i>Summarize the security implications and risks for distributed IT systems.</i>							✓
42	<i>Use communication, negotiation, and collaboration skills as a member of a diverse team.</i>				✓			
43	<i>Describe the attitudes, knowledge and abilities associated with quality customer service.</i>				✓			
44	<i>Produce technical documentation responsive to an identified computing scenario.</i>							
45	<i>Use documentation or a knowledge base to resolve a technical challenge in an identified computing scenario.</i>						✓	
46	<i>Discuss significant trends and emerging technologies and their impact on our global society.</i>						✓	
47	<i>Demonstrate professional behavior in response to an ethically-challenging scenario in computing.</i>				✓		✓	
48	<i>Summarize the tenets of ethics and professional behavior promoted by international computing societies.</i>		✓	✓				
49	<i>Describe IT procurement processes for goods and services.</i>							
50	<i>Summarize the role of IT in supporting the mission and goals of an organization.</i>							

Institution Name: Portland Community College, Portland, OR
Institution URL: www.pcc.edu
Contact Name: Dr. Cara Tang, CIS Faculty
Program Title: Java Application Programming
Program Type: Certificate of Completion
Program URL: www.pcc.edu/programs/computer-info/
Course Descriptions:

1. **CIS133J: Java Programming I** - Covers design, implementation and testing software using Java. Introduces how to write Java programs that solve practical, real world, business-oriented problems using object-oriented design techniques.
2. **CIS 233J: Java Programming II** - Covers the use of Java to access databases and files including XML. Includes creating collections and arrays and using inheritance in Java programs.
3. **CIS 234J: Java Programming III** - Learn to use Java/J2EE to build scalable n-tiered web applications. Covers servlets, JSP, JDBC database connectivity, Enterprise JavaBeans, and SOAP Web Services Technologies. Learn advanced Apache Tomcat web server configuration including how to secure web resources, authenticate users and mask URLs.

Table 10: Portland Community College Certificate Correlation

	Learning Outcome	CIS 133J	CIS 233J	CIS 234J
1	<i>Carry out trouble-shooting strategies for resolving an identified end-user IT problem.</i>			
2	<i>Differentiate among various operating systems.</i>			
3	<i>Explain the process of authentication and authorization between end-user devices and network resources.</i>			
4	<i>Identify a variety of assistive or adaptive technologies and universal design considerations.</i>			
5	<i>Identify basic components of an end-user IT system.</i>			
6	<i>Implement a hardware and software configuration responsive to an identified scenario.</i>			
7	<i>Summarize life-cycle strategies for replacement,</i>			

	<i>reuse, recycling IT technology and resources.</i>			
	Learning Outcome	CIS 133J	CIS 233J	CIS 234J
8	<i>Summarize strategies to support or train users with their IT resources.</i>			
9	<i>Use a variety of practices for making end-user systems secure.</i>			
10	<i>Describe the data management activities associated with the data lifecycle.</i>			
11	<i>Diagram a database design based on an identified scenario.</i>			
12	<i>Differentiate between public and private data.</i>			
13	<i>Discuss applications of data analytics.</i>			
14	<i>Discuss issues relevant to dealing with very large data sets, both structured and unstructured.</i>			
15	<i>Identify database administration tasks.</i>			
16	<i>Produce simple database queries.</i>		✓	✓
17	<i>Use data analytics to support decision making for a given scenario.</i>			
18	<i>Differentiate among a variety of technology-based sensory interactions.</i>			
19	<i>Differentiate among data types, data transfer protocols and file characteristics specific to the targeted use.</i>			
20	<i>Illustrate the activities of a digital media design process.</i>			
21	<i>Implement communication principles into digital media design.</i>			
22	<i>Carry out basic computer network troubleshooting techniques.</i>			
23	<i>Describe the layers, protocols and components of the OSI model.</i>			

	Learning Outcome	CIS 133J	CIS 233J	CIS 234J
24	<i>Diagram the components of an integrated IT system.</i>			
25	<i>Differentiate among various computer networking models.</i>			
26	<i>Differentiate among various techniques for making a computer network secure.</i>			
27	<i>Summarize the flow of data through a computer network scenario.</i>			✓
28	<i>Demonstrate best practices for designing end-user computing interfaces.</i>			
29	<i>Demonstrate the techniques of defensive programming and secure coding.</i>	✓	✓	✓
30	<i>Diagram the phases of the Secure Software Development Lifecycle.</i>			
31	<i>Discuss software development methodologies.</i>		✓	
32	<i>Summarize the differences among various programming languages.</i>			
33	<i>Use a programming or a scripting language to share data across an integrated IT system.</i>		✓	✓
34	<i>Use a programming or a scripting language to solve a problem.</i>	✓	✓	✓
35	<i>Differentiate among strategies for business continuity provisioning of IT resources at the enterprise level.</i>			
36	<i>Discuss data governance and its implications for users as well as IT professionals.</i>			
37	<i>Identify a variety of enterprise-level digital storage technologies.</i>			
38	<i>Implement an application of virtualization.</i>			
39	<i>Modify a system to improve data confidentiality or regulatory compliance.</i>			

	Learning Outcome	CIS 133J	CIS 233J	CIS 234J
40	<i>Summarize the implications of various cloud computing models.</i>			
41	<i>Summarize the security implications and risks for distributed IT systems.</i>			
42	<i>Use communication, negotiation, and collaboration skills as a member of a diverse team.</i>			
43	<i>Describe the attitudes, knowledge and abilities associated with quality customer service.</i>			
44	<i>Produce technical documentation responsive to an identified computing scenario.</i>	✓	✓	✓
45	<i>Use documentation or a knowledge base to resolve a technical challenge in an identified computing scenario.</i>			
46	<i>Discuss significant trends and emerging technologies and their impact on our global society.</i>			
47	<i>Demonstrate professional behavior in response to an ethically-challenging scenario in computing.</i>			
48	<i>Summarize the tenets of ethics and professional behavior promoted by international computing societies.</i>			
49	<i>Describe IT procurement processes for goods and services.</i>			
50	<i>Summarize the role of IT in supporting the mission and goals of an organization.</i>			

Institution Name: Sitting Bull College, Fort Yates, ND
Institution URL: www.sittingbull.edu
Contact Name: Les Siewert, IT Education Specialist
Program Title: Information Technology
Program Type: Associate in Science (A.S.)
Program URL: www.sittingbull.edu/programs/list/DegreePlans.pdf (pages 129-130 and 182-183)
Course Descriptions:

1. **CIS 128: Microcomputer Hardware I** - Students learn the functionality of hardware and software components as well as suggested best practices in maintenance and safety issues. The students, through hands-on activities and labs, will learn to assemble and configure a computer, install operating systems and software, and troubleshoot hardware and software problems. In addition, an introduction to networking is included with this course. This course helps students prepare for CompTIA's A+ certification.
2. **CIS 129: Microcomputer Hardware II** - A study of the types of hardware available to add on to a basic microcomputer system, and which of these are compatible with a particular microcomputer. The course includes such hardware as memory, monitors, printers, modems and hard disks. Simple troubleshooting techniques also will be explained. Students experiment with various software and hardware components during labs.
3. **CIS 164: Networking Fundamentals I** - This course focuses on the following: network terminology and protocols, Local Area Networks (LANs), Wide Area Networks (WANs), Open System Interconnection (OSI) models, cabling, cabling tools, routers, router programming, Ethernet, Internet Protocol (IP) addressing, network standards. This is the first of four courses leading to the Cisco Certified Network Associate (CCNA) certifications.
4. **CIS 165: Networking Fundamentals II** - This course focuses on the following: initial router configuration, Cisco IOS software management, routing protocol configuration, TCP/IP, and Access control lists (ACLs). Students will develop skills in configuring a router, managing Cisco IOS Software, configuring routing protocols, and creating access lists that control access to a router. The second of four courses leading to the Cisco Certified Network Associate CCNA) certification.
5. **CIS 181: Creating Web Pages** - Students create web sites using a current version of a graphical user interface (GUI) web authoring tool.
6. **CIS 212: Operating Systems Client** - The course helps learners to gain the knowledge and skills to install, configure, customize, optimize, and troubleshoot a desktop operating system in a stand-alone and network environment. Windows 7, Windows 8, and Linux and Mac OS are the current focus of the class. The purpose of this course is to offer all the critical information students need to successfully move into a role as an IT professional and support client computers in a business environment. Many hands-on exercises are included which allow students to practice skills as they are learned.
7. **CIS 215: Implementing a Server Environment** - This course provides students with the knowledge and skills necessary to install and configure Microsoft Windows Server 2012 Enterprise and stand-alone and client computers that are part of a workgroup or domain. In addition, this course provides the skills and knowledge necessary to install and configure Linux server, and Mac OS X Server to create file, print, Web and terminal servers.

8. **CIS 297: Information Technology Internship** - This provides the student with the opportunity to experience the world of work in conjunction with their program of study. Each semester hour of credit is equivalent to forty-five (45) contact hours. Prerequisite: Students through advisor approval will only be allowed to complete internship within the last two semesters of the degree plan.
9. **CSCI 122: Visual Basic** - Introduction to programming in the BASIC/Visual BASIC language. (Elective)
10. **CSCI 133: Database Concepts I (SQL)** - This course provides the student with an introduction to the structure and function of database systems, with emphasis on practical applications. Data structures, hierarchical relationships, sequential and indexed searching, updating and deleting records, and data security and recovery will be discussed. The students will use the select statement to query the database and produce the correct outcomes. Students will use functions, join multiple tables and create sub-queries. (Elective)
11. **CSCI 160: Computer Science I (Java)** - An introduction to computer science including problem-solving, algorithm development and structured programming in a high-level language. Emphasis on design, coding, testing and documentation of programs using accepted standards of style. (Elective)
12. **ENS 211: Introduction to GIS/GPS** - This course will teach students to use Geographical Information System (GIS) software and Global Position System (GPS) technology. Students will learn to collect waypoints using GPS technology and will download the waypoint data onto GIS mapping software. Students will develop maps and enter attribute data to correspond to maps that are created. This course will serve as a thorough introduction to GIS software and GPS technology. (Elective)

Table 11: Sitting Bull College Program Correlation

	Learning Outcome	CIS 128	CIS 129	CIS 164	CIS 165	CIS 181	CIS 212	CIS 215	CSCI 122	CSCI 133	CSCI 160	ENS 211	CIS 297
1	<i>Carry out trouble-shooting strategies for resolving an identified end-user IT problem.</i>	✓	✓	✓	✓		✓	✓					✓
2	<i>Differentiate among various operating systems.</i>		✓		✓		✓	✓					✓
3	<i>Explain the process of authentication and authorization between end-user devices and network resources.</i>				✓		✓	✓					
4	<i>Identify a variety of assistive or adaptive technologies and universal design considerations.</i>	✓	✓			✓			✓	✓	✓		
5	<i>Identify basic components of an end-user IT system.</i>	✓					✓					✓	✓
6	<i>Implement a hardware and software configuration responsive to an identified scenario.</i>			✓	✓		✓	✓		✓		✓	✓
7	<i>Summarize life-cycle strategies for replacement,</i>	✓	✓				✓						✓

	<i>reuse, recycling IT technology and resources.</i>												
	Learning Outcome	CIS 128	CIS 129	CIS 164	CIS 165	CIS 181	CIS 212	CIS 215	CSCI 122	CSCI 133	CSCI 160	ENS 211	CIS 297
8	<i>Summarize strategies to support or train users with their IT resources.</i>		✓		✓	✓	✓		✓	✓	✓		
9	<i>Use a variety of practices for making end-user systems secure.</i>						✓	✓					
10	<i>Describe the data management activities associated with the data lifecycle.</i>					✓		✓		✓			
11	<i>Diagram a database design based on an identified scenario.</i>									✓			
12	<i>Differentiate between public and private data.</i>							✓		✓			
13	<i>Discuss applications of data analytics.</i>							✓		✓			✓
14	<i>Discuss issues relevant to dealing with very large data sets, both structured and unstructured.</i>							✓		✓			
15	<i>Identify database administration tasks.</i>							✓		✓			
16	<i>Produce simple database queries.</i>									✓			
17	<i>Use data analytics to support decision making for a given scenario.</i>							✓		✓			✓
18	<i>Differentiate among a variety of technology-based sensory interactions.</i>					✓	✓		✓		✓	✓	
19	<i>Differentiate among data types, data transfer protocols and file characteristics specific to the targeted use.</i>					✓		✓		✓		✓	
20	<i>Illustrate the activities of a digital media design process.</i>					✓			✓		✓		
21	<i>Implement communication principles into digital media design.</i>					✓			✓		✓		
22	<i>Carry out basic computer network troubleshooting techniques.</i>		✓	✓	✓		✓	✓					✓
23	<i>Describe the layers, protocols and components of the OSI model.</i>			✓	✓			✓					

	Learning Outcome	CIS 128	CIS 129	CIS 164	CIS 165	CIS 181	CIS 212	CIS 215	CSCI 122	CSCI 133	CSCI 160	ENS 211	CIS 297
24	<i>Diagram the components of an IT integrated system.</i>							✓		✓			
25	<i>Differentiate among various computer networking models.</i>		✓	✓	✓			✓					
26	<i>Differentiate among various techniques for making a computer network secure.</i>				✓			✓					✓
27	<i>Summarize the flow of data through a computer network scenario.</i>				✓			✓					
28	<i>Demonstrate best practices for designing end-user computing interfaces.</i>					✓			✓	✓	✓		
29	<i>Demonstrate the techniques of defensive programming and secure coding.</i>							✓	✓	✓	✓		
30	<i>Diagram the phases of the Secure Software Development Lifecycle.</i>								✓		✓		
31	<i>Discuss software development methodologies.</i>								✓		✓		
32	<i>Summarize the differences among various programming languages.</i>								✓		✓		
33	<i>Use a programming or a scripting language to share data across an integrated IT system.</i>							✓		✓			
34	<i>Use a programming or a scripting language to solve a problem.</i>							✓	✓	✓	✓		
35	<i>Differentiate among strategies for business continuity provisioning of IT resources at the enterprise level.</i>				✓			✓					
36	<i>Discuss data governance and its implications for users as well as IT professionals.</i>				✓			✓			✓		✓
37	<i>Identify a variety of enterprise-level digital storage technologies.</i>	✓			✓			✓					
38	<i>Implement an application of virtualization.</i>						✓	✓					✓
39	<i>Modify a system to improve data confidentiality or regulatory compliance.</i>							✓		✓			

	Learning Outcome	CIS 128	CIS 129	CIS 164	CIS 165	CIS 181	CIS 212	CIS 215	CSCI 122	CSCI 133	CSCI 160	ENS 211	CIS 297
40	<i>Summarize the implications of various cloud computing models.</i>							✓		✓			
41	<i>Summarize the security implications and risks for distributed IT systems.</i>							✓		✓			
42	<i>Use communication, negotiation, and collaboration skills as a member of a diverse team.</i>	✓	✓		✓							✓	✓
43	<i>Describe the attitudes, knowledge and abilities associated with quality customer service.</i>	✓	✓		✓	✓							✓
44	<i>Produce technical documentation responsive to an identified computing scenario.</i>	✓	✓		✓				✓	✓	✓	✓	✓
45	<i>Use documentation or a knowledge base to resolve a technical challenge in an identified computing scenario.</i>	✓	✓	✓	✓	✓		✓					✓
46	<i>Discuss significant trends and emerging technologies and their impact on our global society.</i>				✓							✓	✓
47	<i>Demonstrate professional behavior in response to an ethically-challenging scenario in computing.</i>		✓		✓		✓			✓			✓
48	<i>Summarize the tenets of ethics and professional behavior promoted by international computing societies.</i>		✓		✓			✓					✓
49	<i>Describe IT procurement processes for goods and services.</i>				✓			✓					✓
50	<i>Summarize the role of IT in supporting the mission and goals of an organization.</i>		✓		✓			✓					✓

Committee for
Computing
Education in
Community
Colleges



Association for
Computing Machinery

Advancing Computing as a Science & Profession