The Pathway Knowledge and Skills Chart describes what all/most learners/workers need to know and be able to do to demonstrate competence within a career pathway. Following the pathway description, there are four sets of knowledge and skill expectations:

A. Foundational Academic Expectations
B. Essential Knowledge and Skills
C. Cluster (Foundation) Knowledge and Skills
D. Pathway Knowledge and Skills

PATHWAY DESCRIPTION

Programming and Software Development: Careers in Programming and Software Development involve the design development implementation and maintenance of computer systems and software, requiring knowledge of computer operating systems, programming languages and software development. People with expertise in programming and software development work with cutting-edge technologies to develop tomorrow's products for use by businesses and consumers. While many of the career opportunities in this area are in software companies, large organizations of other types—such as Financial Services and Business—also offer many opportunities. People with expertise in programming and software development are in high demand, doing work such as creating the software that launches and runs NASA space shuttles.

A. FOUNDATIONAL ACADEMIC EXPECTATIONS

All secondary students should meet their state's academic standards. All Essential Cluster and Pathway Knowledge and Skills are predicated on the assumption that foundational academic skills have been attained. Some knowledge and skill statements will further define critical linkages and applications of academics in the cluster and/or pathway.

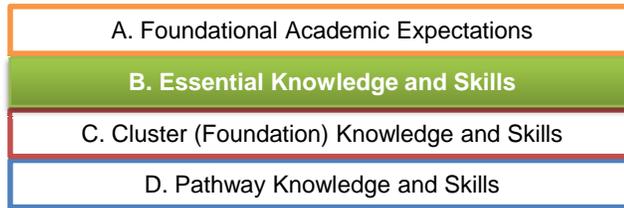| |
|---|
| **A. Foundational Academic Expectations** |
| B. Essential Knowledge and Skills |
| C. Cluster (Foundation) Knowledge and Skills |
| D. Pathway Knowledge and Skills |
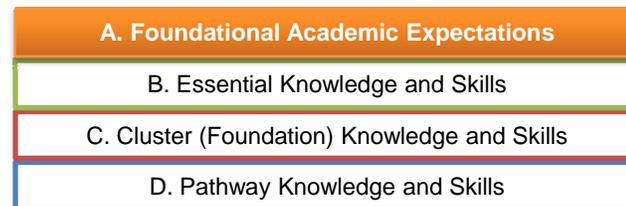
B. ESSENTIAL KNOWLEDGE AND SKILLS

The following Essential Knowledge and Skill statements apply to careers in all clusters and pathways. Persons preparing for careers in this pathway should be able to demonstrate these skills in the context of this cluster and pathway.

A. Foundational Academic Expectations
B. Essential Knowledge and Skills
C. Cluster (Foundation) Knowledge and Skills
D. Pathway Knowledge and Skills

Essential Topic ESS01	**ACADEMIC FOUNDATIONS:** *Achieve additional academic knowledge and skills required to pursue the full range of career and postsecondary education opportunities within a career cluster.*

ESS01.01   **Complete required training, education, and certification to prepare for employment in a particular career field.**

ESS01.01.01   Identify training, education and certification requirements for occupational choice.

ESS01.01.02   Participate in career-related training and/or degree programs.

ESS01.01.03   Pass certification tests to qualify for licensure and/or certification in chosen occupational area.

ESS01.02   **Demonstrate language arts knowledge and skills required to pursue the full range of post-secondary education and career opportunities.**

ESS01.02.01   Model behaviors that demonstrate active listening.

ESS01.02.02   Adapt language for audience, purpose, situation. (i.e. diction/structure, style).

ESS01.02.03   Organize oral and written information.

ESS01.02.04   Compose focused copy for a variety of written documents such as agendas, audio-visuals, bibliographies, drafts, forms/documents, notes, oral presentations, reports, and technical terminology.

ESS01.02.05   Edit copy to create focused written documents such as agendas, audio-visuals, bibliographies, drafts, forms/documents, notes, oral presentations, reports, and technical terminology.

ESS01.02.06   Comprehend key elements of oral and written information such as cause/effect, comparisons/contrasts, conclusions, context, purpose, charts/tables/graphs, evaluation/critiques, mood, persuasive text, sequence, summaries, and technical subject matter.

ESS01.02.07   Evaluate oral and written information for accuracy, adequacy/sufficiency, appropriateness, clarity, conclusions/solutions, fact/opinion, propaganda, relevancy, validity, and relationship of ideas.

ESS01.02.08   Identify assumptions, purpose, outcomes/solutions, and propaganda techniques.

ESS01.02.09   Predict potential outcomes and/or solutions based on oral and written information regarding trends.

ESS01.02.10   Present formal and informal speeches including discussion, information requests, interpretation, and persuasive arguments.

ESS01.03	**Demonstrate mathematics knowledge and skills required to pursue the full range of post-secondary education and career opportunities.**
ESS01.03.01	Identify whole numbers, decimals, and fractions.
ESS01.03.02	Demonstrate knowledge of basic arithmetic operations such as addition, subtraction, multiplication, and division.
ESS01.03.03	Demonstrate use of relational expressions such as equal to, not equal, greater than, less than, etc.
ESS01.03.04	Apply data and measurements to solve a problem.
ESS01.03.05	Analyze Mathematical problem statements for missing and/or irrelevant data.
ESS01.03.06	Construct charts/tables/graphs from functions and data.
ESS01.03.07	Analyze data when interpreting operational documents.
ESS01.04	**Demonstrate science knowledge and skills required to pursue the full range of post-secondary and career education opportunities.**
ESS01.04.01	Evaluate scientific constructs including conclusions, conflicting data, controls, data, inferences, limitations, questions, sources of errors, and variables.
ESS01.04.02	Apply scientific methods in qualitative and quantitative analysis, data gathering, direct and indirect observation, predictions, and problem identification.

Essential Topic ESS02	**COMMUNICATIONS:** *Use oral and written communication skills in creating, expressing and interpreting information and ideas including technical terminology and information.*
ESS02.01	**Select and employ appropriate reading and communication strategies to learn and use technical concepts and vocabulary in practice.**
ESS02.01.01	Determine the most appropriate reading strategy for identifying the overarching purpose of a text (i.e. skimming, reading for detail, reading for meaning or critical analysis).
ESS02.01.02	Demonstrate use of content, technical concepts and vocabulary when analyzing information and following directions.
ESS02.01.03	Select the reading strategy or strategies needed to fully comprehend the content within a written document (i.e., skimming, reading for detail, reading for meaning or critical analysis).
ESS02.01.04	Interpret information, data, and observations to apply information learned from reading to actual practice.
ESS02.01.05	Transcribe information, data, and observations to apply information learned from reading to actual practice.
ESS02.01.06	Communicate information, data, and observations to apply information learned from reading to actual practice.

ESS02.02		**Demonstrate use of the concepts, strategies, and systems for obtaining and conveying ideas and information to enhance communication in the workplace.**
	ESS02.02.01	Employ verbal skills when obtaining and conveying information.
	ESS02.02.02	Record information needed to present a report on a given topic or problem.
	ESS02.02.03	Write internal and external business correspondence that conveys and/or obtains information effectively.
	ESS02.02.04	Communicate with other employees to clarify workplace objectives.
	ESS02.02.05	Communicate effectively with customers and employees to foster positive relationships.
ESS02.03		**Locate, organize and reference written information from various sources to communicate with co-workers and clients/participants.**
	ESS02.03.01	Locate written information used to communicate with co-workers and customers.
	ESS02.03.02	Organize information to use in written and oral communications.
	ESS02.03.03	Reference the sources of information.
ESS02.04		**Evaluate and use information resources to accomplish specific occupational tasks.**
	ESS02.04.01	Use informational texts, Internet web sites, and/or technical materials to review and apply information sources for occupational tasks.
	ESS02.04.02	Evaluate the reliability of information from informational texts, Internet Web sites, and/or technical materials and resources.
ESS02.05		**Use correct grammar, punctuation and terminology to write and edit documents.**
	ESS02.05.01	Compose multi-paragraph documents clearly, succinctly, and accurately.
	ESS02.05.02	Use descriptions of audience and purpose when preparing and editing written documents.
	ESS02.05.03	Use correct grammar, spelling, punctuation, and capitalization when preparing written documents.
ESS02.06		**Develop and deliver formal and informal presentations using appropriate media to engage and inform audiences.**
	ESS02.06.01	Prepare oral presentations to provide information for specific purposes and audiences.
	ESS02.06.02	Identify support materials that will enhance an oral presentation.
	ESS02.06.03	Prepare support materials that will enhance an oral presentation.
	ESS02.06.04	Deliver an oral presentation that sustains listeners' attention and interest.
	ESS02.06.05	Align presentation strategies to the intended audience.
	ESS02.06.06	Implement multi-media strategies for presentations.
ESS02.07		**Interpret verbal and nonverbal cues/behaviors to enhance communication with co-workers and clients/participants.**

| ESS02.07.01 | Interpret verbal behaviors when communicating with clients and co-workers. |
| ESS02.07.02 | Interpret nonverbal behaviors when communicating with clients and co-workers. |

ESS02.08   **Apply active listening skills to obtain and clarify information.**
| ESS02.08.01 | Interpret a given verbal message/information. |
| ESS02.08.02 | Respond with restatement and clarification techniques to clarify information. |

ESS02.09   **Develop and interpret tables, charts, and figures to support written and oral communications.**
| ESS02.09.01 | Create tables, charts, and figures to support written and oral communications. |
| ESS02.09.02 | Interpret tables, charts, and figures used to support written and oral communication. |

ESS02.10   **Listen to and speak with diverse individuals to enhance communication skills.**
| ESS02.10.01 | Apply factors and strategies for communicating with a diverse workforce. |
| ESS02.10.02 | Demonstrate ability to communicate and resolve conflicts within a diverse workforce. |

ESS02.11   **Exhibit public relations skills to increase internal and external customer/client satisfaction.**
| ESS02.11.01 | Communicate effectively when developing positive customer/client relationships. |

| **Essential Topic ESS03** | **PROBLEM-SOLVING AND CRITICAL THINKING:** *Solve problems using critical thinking skills (analyze, synthesize, and evaluate) independently and in teams. Solve problems using creativity and innovation.* |

ESS03.01   **Employ critical thinking skills independently and in teams to solve problems and make decisions (e.g., analyze, synthesize and evaluate).**
ESS03.01.01	Identify common tasks that require employees to use problem-solving skills.
ESS03.01.02	Analyze elements of a problem to develop creative solutions.
ESS03.01.03	Describe the value of using problem-solving and critical thinking skills to improve a situation or process.
ESS03.01.04	Create ideas, proposals, and solutions to problems.
ESS03.01.05	Evaluate ideas, proposals, and solutions to problems.
ESS03.01.06	Use structured problem-solving methods when developing proposals and solutions.
ESS03.01.07	Generate new and creative ideas to solve problems by brainstorming possible solutions.
ESS03.01.08	Critically analyze information to determine value to the problem-solving task.

ESS03.01.09	Guide individuals through the process of recognizing concerns and making informed decisions.
ESS03.01.10	Identify alternatives using a variety of problem-solving and critical thinking skills.
ESS03.01.11	Evaluate alternatives using a variety of problem-solving and critical thinking skills.

ESS03.02   **Employ critical thinking and interpersonal skills to resolve conflicts with staff and/or customers.**

ESS03.02.01	Analyze situations and behaviors that affect conflict management.
ESS03.02.02	Determine best options/outcomes for conflict resolution using critical thinking skills.
ESS03.02.03	Identify with others' feelings, needs, and concerns.
ESS03.02.04	Implement stress management techniques.
ESS03.02.05	Resolve conflicts with/for customers using conflict resolution skills.
ESS03.02.06	Implement conflict resolution skills to address staff issues/problems.

ESS03.03   **Identify, write and monitor workplace performance goals to guide progress in assigned areas of responsibility and accountability.**

ESS03.03.01	Write realistic performance goals, objectives and action plans.
ESS03.03.02	Monitor performance goals and adjust as necessary.
ESS03.03.03	Recognize goal achievement using appropriate rewards in the workplace.
ESS03.03.04	Communicate goal achievement with managers and co-workers.

ESS03.04   **Conduct technical research to gather information necessary for decision-making.**

ESS03.04.01	Align the information gathered to the needs of the audience.
ESS03.04.02	Gather technical information and data using a variety of resources.
ESS03.04.03	Analyze information and data for value to the research objectives.
ESS03.04.04	Evaluate information and data to determine value to research objectives.

Essential Topic ESS04	**INFORMATION TECHNOLOGY APPLICATIONS:** *Use information technology tools specific to the career cluster to access, manage, integrate, and create information.*

ESS04.01   **Use Personal Information Management (PIM) applications to increase workplace efficiency.**

ESS04.01.01	Manage personal schedules and contact information.
ESS04.01.02	Create memos and notes.

ESS04.02   **Employ technological tools to expedite workflow.**

ESS04.02.01	Use information technology tools to manage and perform work responsibilities.

ESS04.03   **Operate electronic mail applications to communicate within a workplace.**

ESS04.03.01	Use email to share files and documents.

ESS04.03.02	Identify the functions and purpose of email systems.
ESS04.03.03	Use email to communicate within and across organizations.
ESS04.04	**Operate Internet applications to perform workplace tasks.**
ESS04.04.01	Access and navigate Internet (e.g., use a web browser).
ESS04.04.02	Search for information and resources.
ESS04.04.03	Evaluate Internet resources for reliability and validity.
ESS04.05	**Operate writing and publishing applications to prepare business communications.**
ESS04.05.01	Prepare simple documents and other business communications.
ESS04.05.02	Prepare reports and other business communications by integrating graphics and other non-text elements.
ESS04.05.03	Prepare complex multi-media publications.
ESS04.06	**Operate presentation applications to prepare presentations.**
ESS04.06.01	Prepare presentations for training, sales and information sharing.
ESS04.06.02	Deliver presentations with supporting materials.
ESS04.07	**Employ spreadsheet applications to organize and manipulate data.**
ESS04.07.01	Create a spreadsheet.
ESS04.07.02	Perform calculations and analyses on data using a spreadsheet.
ESS04.08	**Employ database applications to manage data.**
ESS04.08.01	Manipulate data elements.
ESS04.08.02	Manage interrelated data elements.
ESS04.08.03	Analyze interrelated data elements.
ESS04.08.04	Generate reports showing interrelated data elements.
ESS04.09	**Employ collaborative/groupware applications to facilitate group work.**
ESS04.09.01	Facilitate group work through management of shared schedule and contact information.
ESS04.09.02	Facilitate group work through management of shared files and online information.
ESS04.09.03	Facilitate group work through instant messaging or virtual meetings.
ESS04.10	**Employ computer operations applications to manage work tasks.**
ESS04.10.01	Manage computer operations.
ESS04.10.02	Manage file storage.
ESS04.10.03	Compress or alter files.
ESS04.11	**Use computer-based equipment (containing embedded computers or processors) to control devices.**
ESS04.11.01	Operate computer driven equipment and machines.
ESS04.11.02	Use installation and operation manuals.
ESS04.11.03	Troubleshoot computer driven equipment and machines.
ESS04.11.04	Access support as needed to maintain operation of computer driven equipment and machines.

Essential Topic ESS05	**SYSTEMS:** *Understand roles within teams, work units, departments, organizations, inter-organizational systems, and the larger environment. Identify how key organizational systems affect organizational performance and the quality of products and services. Understand global context of industries and careers.*

ESS05.01	**Describe the nature and types of business organizations to build an understanding of the scope of organizations.**
ESS05.01.01	List the types and functions of businesses.
ESS05.01.02	Describe the types and functions of businesses.
ESS05.01.03	Explain the functions and interactions of common departments within a business.

ESS05.02	**Implement quality control systems and practices to ensure quality products and services.**
ESS05.02.01	Describe quality control standards and practices common to the workplace.

Essential Topic ESS06	**SAFETY, HEALTH AND ENVIRONMENTAL:** *Understand the importance of health, safety, and environmental management systems in organizations and their importance to organizational performance and regulatory compliance. Follow organizational policies and procedures and contribute to continuous improvement in performance and compliance.*

ESS06.01	**Implement personal and jobsite safety rules and regulations to maintain safe and healthful working conditions and environments.**
ESS06.01.01	Assess workplace conditions with regard to safety and health.
ESS06.01.02	Align safety issues with appropriate safety standards to ensure a safe workplace/jobsite.
ESS06.01.03	Identify safety hazards common to workplaces.
ESS06.01.04	Identify safety precautions to maintain a safe worksite.
ESS06.01.05	Select appropriate personal protective equipment as needed for a safe workplace/jobsite.
ESS06.01.06	Inspect personal protective equipment commonly used for selected career pathway.
ESS06.01.07	Use personal protective equipment according to manufacturer rules and regulations.
ESS06.01.08	Employ a safety hierarchy and communication system within the workplace/jobsite.
ESS06.01.09	Implement safety precautions to maintain a safe worksite.

ESS06.02	**Complete work tasks in accordance with employee rights and responsibilities and employers obligations to maintain workplace safety and health.**
ESS06.02.01	Identify rules and laws designed to promote safety and health in the workplace.
ESS06.02.02	State the rationale of rules and laws designed to promote safety and health.

ESS06.03	**Employ emergency procedures as necessary to provide aid in workplace accidents.**
ESS06.03.01	Use knowledge of First Aid procedures as necessary.
ESS06.03.02	Use knowledge of CPR procedures as necessary.
ESS06.03.03	Use safety equipment as necessary.
ESS06.04	**Employ knowledge of response techniques to create a disaster and/or emergency response plan.**
ESS06.04.01	Complete an assessment of an emergency and/or disaster situation.
ESS06.04.02	Create an emergency and/or disaster plan.

Essential Topic ESS07	**LEADERSHIP AND TEAMWORK:** *Use leadership and teamwork skills in collaborating with others to accomplish organizational goals and objectives.*

ESS07.01	**Employ leadership skills to accomplish organizational goals and objectives.**
ESS07.01.01	Analyze the various roles of leaders within organizations (e.g. contribute ideas; share in building an organization; act as role models to employees by adhering to company policies, procedures, and standards; promote the organization's vision; and mentor others).
ESS07.01.02	Exhibit traits such as empowerment, risk, communication, focusing on results, decision-making, problem solution, and investment in individuals when leading a group in solving a problem.
ESS07.01.03	Exhibit traits such as compassion, service, listening, coaching, developing others, team development, and understanding and appreciating others when acting as a manager of others in the workplace.
ESS07.01.04	Exhibit traits such as enthusiasm, creativity, conviction, mission, courage, concept, focus, principle-centered living, and change when interacting with others in general.
ESS07.01.05	Consider issues related to self, team, community, diversity, environment, and global awareness when leading others.
ESS07.01.06	Exhibit traits such as innovation, intuition, adaptation, life-long learning and coachability to develop leadership potential over time.
ESS07.01.07	Analyze leadership in relation to trust, positive attitude, integrity, and willingness to accept key responsibilities in a work situation.
ESS07.01.08	Describe observations of outstanding leaders using effective management styles.
ESS07.01.09	Participate in civic and community leadership and teamwork opportunities to enhance skills.
ESS07.02	**Employ organizational and staff development skills to foster positive working relationships and accomplish organizational goals.**
ESS07.02.01	Implement organizational skills when facilitating others' work efforts.

ESS07.02.02	Explain how to manage a staff that satisfies work demands while adhering to budget constraints.
ESS07.02.03	Describe how staff growth and development to increase productivity and employee satisfaction.
ESS07.02.04	Organize team involvement within a group environment.
ESS07.02.05	Work with others to develop and gain commitment to team goals.
ESS07.02.06	Distribute responsibility and work load fairly.
ESS07.02.07	Model leadership and teamwork qualities to aid in employee morale.
ESS07.02.08	Identify best practices for successful team functioning.
ESS07.02.09	Explain best practices for successful team functioning.
ESS07.03	**Employ teamwork skills to achieve collective goals and use team members' talents effectively.**
ESS07.03.01	Work with others to achieve objectives in a timely manner.
ESS07.03.02	Promote the full involvement and use of team members' individual talents and skills.
ESS07.03.03	Employ conflict-management skills to facilitate solutions.
ESS07.03.04	Demonstrate teamwork skills through working cooperatively with co-workers, supervisory staff, and others, both in and out of the organization, to achieve particular tasks.
ESS07.03.05	Demonstrate teamwork processes that provide team building, consensus, continuous improvement, respect for the opinions of others, cooperation, adaptability, and conflict resolution.
ESS07.03.06	Develop plans to improve team performance.
ESS07.03.07	Demonstrate commitment to and a positive attitude toward team goals.
ESS07.03.08	Take responsibility for shared group and individual work tasks.
ESS07.03.09	Assist team members in completing their work.
ESS07.03.10	Adapt effectively to changes in projects and work activities.
ESS07.03.11	Negotiate effectively to arrive at decisions.
ESS07.04	**Establish and maintain effective working relationships with all levels of personnel and other departments in order to accomplish objectives and tasks.**
ESS07.04.01	Build effective working relationships using interpersonal skills.
ESS07.04.02	Use positive interpersonal skills to work cooperatively with co-workers representing different cultures, genders and backgrounds.
ESS07.04.03	Manage personal skills to accomplish assignments.
ESS07.04.04	Treat people with respect.
ESS07.04.05	Provide constructive praise and criticism.
ESS07.04.06	Demonstrate sensitivity to and value for diversity.
ESS07.04.07	Manage stress and control emotions.
ESS07.05	**Conduct and participate in meetings to accomplish work tasks.**
ESS07.05.01	Develop meeting goals, objectives and agenda.
ESS07.05.02	Assign responsibilities for preparing materials and leading discussions.
ESS07.05.03	Prepare materials for leading discussion.
ESS07.05.04	Assemble and distribute meeting materials.
ESS07.05.05	Conduct meeting to achieve objectives within scheduled time.

ESS07.05.06	Demonstrate effective communication skills in meetings.
ESS07.05.07	Produce meeting minutes including decisions and next steps.
ESS07.05.08	Use parliamentary procedure, as needed, to conduct meetings.
ESS07.06	**Employ mentoring skills to inspire and teach others.**
ESS07.06.01	Use motivational techniques to enhance performance in others.
ESS07.06.02	Provide guidance to enhance performance in others.

Essential Topic ESS08	**ETHICS AND LEGAL RESPONSIBILITIES:** *Know and understand the importance of professional ethics and legal responsibilities.*
ESS08.01	**Apply ethical reasoning to a variety of workplace situations in order to make ethical decisions.**
ESS08.01.01	Evaluate alternative responses to workplace situations based on legal responsibilities and employer policies.
ESS08.01.02	Evaluate alternative responses to workplace situations based on personal or professional ethical responsibilities.
ESS08.01.03	Identify personal and long-term workplace consequences of unethical or illegal behaviors.
ESS08.01.04	Explain personal and long-term workplace consequences of unethical or illegal behaviors.
ESS08.01.05	Determine the most appropriate response to workplace situations based on legal and ethical considerations.
ESS08.01.06	Explain the most appropriate response to workplace situations based on legal and ethical considerations.
ESS08.02	**Interpret and explain written organizational policies and procedures to help employees perform their jobs according to employer rules and expectations.**
ESS08.02.01	Locate information on organizational policies in handbooks and manuals.
ESS08.02.02	Discuss how specific organizational policies and procedures influence a specific work situation.

Essential Topic ESS09	**EMPLOYABILITY AND CAREER DEVELOPMENT:** *Know and understand the importance of employability skills. Explore, plan, and effectively manage careers. Know and understand the importance of entrepreneurship skills.*
ESS09.01	**Identify and demonstrate positive work behaviors and personal qualities needed to be employable.**
ESS09.01.01	Demonstrate self-discipline, self-worth, positive attitude, and integrity in a work situation.
ESS09.01.02	Demonstrate flexibility and willingness to learn new knowledge and skills.
ESS09.01.03	Exhibit commitment to the organization.

ESS09.01.04	Identify how work varies with regard to site, from indoor confined spaces to outdoor areas, including aerial space and a variety of climatic and physical conditions.
ESS09.01.05	Apply communication strategies when adapting to a culturally diverse environment.
ESS09.01.06	Manage resources in relation to the position (i.e. budget, supplies, computer, etc).
ESS09.01.07	Identify positive work-qualities typically desired in each of the career cluster's pathways.
ESS09.01.08	Manage work roles and responsibilities to balance them with other life roles and responsibilities.

ESS09.02   **Develop a personal career plan to meet career goals and objectives.**

ESS09.02.01	Develop career goals and objectives as part of a plan for future career direction.
ESS09.02.02	Develop strategies to reach career objectives.

ESS09.03   **Demonstrate skills related to seeking and applying for employment to find and obtain a desired job.**

ESS09.03.01	Use multiple resources to locate job opportunities.
ESS09.03.02	Prepare a résumé.
ESS09.03.03	Prepare a letter of application.
ESS09.03.04	Complete an employment application.
ESS09.03.05	Interview for employment.
ESS09.03.06	List the standards and qualifications that must be met in order to enter a given industry.
ESS09.03.07	Employ critical thinking and decision-making skills to exhibit qualifications to a potential employer.

ESS09.04   **Maintain a career portfolio to document knowledge, skills and experience in a career field.**

ESS09.04.01	Select educational and work history highlights to include in a career portfolio.
ESS09.04.02	Produce a record of work experiences, licenses, certifications and products.
ESS09.04.03	Organize electronic or physical portfolio for use in demonstrating knowledge, skills and experiences.

ESS09.05   **Demonstrate skills in evaluating and comparing employment opportunities in order to accept employment positions that match career goals.**

ESS09.05.01	Compare employment opportunities to individual needs and career plan objectives.
ESS09.05.02	Evaluate employment opportunities based upon individual needs and career plan objectives.
ESS09.05.03	Demonstrate appropriate methods for accepting or rejecting employment offers.

ESS09.06	**Identify and exhibit traits for retaining employment to maintain employment once secured.**
ESS09.06.01	Model behaviors that demonstrate reliability and dependability.
ESS09.06.02	Maintain appropriate dress and behavior for the job to contribute to a safe and effective workplace/jobsite.
ESS09.06.03	Complete required employment forms and documentation such as I-9 form, work visa, W-4 and licensures to meet employment requirements.
ESS09.06.04	Summarize key activities necessary to retain a job in the industry.
ESS09.06.05	Identify positive work behaviors and personal qualities necessary to retain employment.
ESS09.07	**Identify and explore career opportunities in one or more career pathways to build an understanding of the opportunities available in the cluster.**
ESS09.07.01	Locate and identify career opportunities that appeal to personal career goals.
ESS09.07.02	Match personal interest and aptitudes to selected careers.
ESS09.08	**Recognize and act upon requirements for career advancement to plan for continuing education and training.**
ESS09.08.01	Identify opportunities for career advancement.
ESS09.08.02	Pursue education and training opportunities to acquire skills necessary for career advancement.
ESS09.08.03	Examine the organization and structure of various segments of the industry to prepare for career advancement.
ESS09.08.04	Research local and regional labor (workforce) market and job growth information to project potential for advancement.
ESS09.08.05	Manage employment relations to make career advancements.
ESS09.09	**Continue professional development to keep current on relevant trends and information within the industry.**
ESS09.09.01	Use self assessment, organizational priorities, journals, Internet sites, professional associations, peers and other resources to develop goals that address training, education and self-improvement issues.
ESS09.09.02	Read trade magazines and journals, manufacturers' catalogues, industry publications and Internet sites to keep current on industry trends.
ESS09.09.03	Participate in relevant conferences, workshops, mentoring activities and in-service training to stay current with recent changes in the field.
ESS09.10	**Examine licensing, certification and credentialing requirements at the national, state and local levels to maintain compliance with industry requirements.**
ESS09.10.01	Examine continuing education requirements related to licensing, certification, and credentialing requirements at the local, state and national levels for chosen occupation.

| ESS09.10.02 | Examine the procedures and paperwork involved in maintaining and updating licensure, certification and credentials for chosen occupation. |
| ESS09.10.03 | Align ongoing licensing, certification and credentialing requirements to career plans and goals. |

ESS09.11 **Examine employment opportunities in entrepreneurship to consider entrepreneurship as an option for career planning.**

| ESS09.11.01 | Describe the opportunities for entrepreneurship in a given industry. |

| **Essential Topic ESS10** | **TECHNICAL SKILLS:** *Use of technical knowledge and skills required to pursue careers in all career cluster, including knowledge of design, operation, and maintenance of technological systems critical to the career cluster.* |

ESS10.01 **Employ information management techniques and strategies in the workplace to assist in decision-making.**

ESS10.01.01	Use information literacy skills when accessing, evaluating and disseminating information.
ESS10.01.02	Describe the nature and scope of information management.
ESS10.01.03	Maintain records to facilitate ongoing business operations.

ESS10.02 **Employ planning and time management skills and tools to enhance results and complete work tasks.**

ESS10.02.01	Develop goals and objectives.
ESS10.02.02	Prioritize tasks to be completed.
ESS10.02.03	Develop timelines using time management knowledge and skills.
ESS10.02.04	Use project-management skills to improve workflow and minimize costs.

C. CLUSTER (FOUNDATION) KNOWLEDGE AND SKILLS

The following Cluster (Foundation) Knowledge and Skill statements apply to all careers in the Information Technology Cluster. Persons preparing for careers in the Information Technology Cluster should be able to demonstrate these skills in addition to those found on the Essential Knowledge and Skills Chart.

| A. Foundational Academic Expectations |
| B. Essential Knowledge and Skills |
| **C. Cluster (Foundation) Knowledge and Skills** |
| D. Pathway Knowledge and Skills |

| **Cluster Topic ITC01** | **ACADEMIC FOUNDATIONS:** *Achieve additional academic knowledge and skills required to pursue the full range of career and postsecondary education opportunities within a career cluster.* |
| | *No additional statements in this topic beyond those found in the Essential Knowledge and Skills Chart.* |

Cluster Topic ITC02	**COMMUNICATIONS:** *Use oral and written communication skills in creating, expressing and interpreting information and ideas including technical terminology and information.*

ITC02.01	**Develop positive customer relations to build and maintain a customer base in the IT industry.**
ITC02.01.01	Demonstrate knowledge of organization's offerings and of customers' importance to the organization.
Sample Indicators	Identify organization's products and services (including own strengths as an agent of the company).
	Recognize the importance of all customers to the business.
ITC02.01.02	Demonstrate ability to assist customers in a professional manner.
Sample Indicators	Determine customers' individual needs.
	Project a professional business image (e.g., appearance, voice, grammar, word usage, enunciation, nonverbal communication).
	Interact with customers and colleagues in a professional manner (e.g., prompt, friendly, courteous, respectful, helpful, knowledgeable, understandable).
	Ensure that your assistance promotes the best interests of the company.
ITC02.01.03	Effectively use organizational protocols and systems to fulfill customer service requirements.
Sample Indicators	Comply with established business protocols and company policies.
	Communicate company policies to customers.
	Handle merchandise returns in accordance with customer service policy.
	Handle customer complaints in accordance with customer service policy.
	Facilitate customer service through the maintenance of key information systems.
ITC02.01.04	Ensure that customers' needs are met to maintain a customer base.
	Follow through on commitments made to customers(e.g., special orders, delivery specifications, new items).
Sample Indicators	Maintain customer base.
ITC02.02	**Perform scheduling functions to meet customer needs.**
ITC02.02.01	Schedule customer appointments.
Sample Indicators	Create calendars/schedules.
	Maintain appointment calendars.
	Process requests for appointments.
	Verify appointments.
	Notify customers of changes in schedule.
	Manage scheduling conflicts.
ITC02.02.02	Document results of customer appointments.
Sample Indicators	Document results.

Cluster Topic ITC03	**PROBLEM-SOLVING AND CRITICAL THINKING:** *Solve problems using critical thinking skills (analyze, synthesize, and evaluate) independently and in teams. Solve problems using creativity and innovation.*

ITC03.01	**Use product/service design processes and guidelines to produce a quality IT product/service.**
ITC03.01.01	Summarize the process of IT product/service design.
Sample Indicators	Test products for reliability.
	Initiate predictive maintenance procedures.

	Document a Quality Assurance (QA) program (includes creating a plan and evaluating effectiveness of the program).
ITC03.01.02	Plan for products/services using reliability factors.
ITC03.01.03	Create products/services using reliability factors.
ITC03.01.04	Test new products/services for reliability.
ITC03.01.05	Maintain the reliability of new products/services.
ITC03.02	**Implement problem-solving processes to evaluate and verify the nature of problems in the IT industry.**
ITC03.02.01	Explain information systems theory and practice.
Sample Indicators	Demonstrate knowledge of the underlying concepts of the information systems discipline.
	Demonstrate knowledge of methods for achieving productivity in knowledge work.
	Apply general systems theory to the analysis and development of an information system.
	Identify procedures for formal problem-solving.
	Demonstrate knowledge of the fundamental concept of information theory and organizational system processes.
	Identify the essential properties of information systems.
ITC03.02.02	Explain information systems problem-solving techniques and approaches.
ITC03.02.03	Evaluate information systems problem-solving techniques and approaches.
ITC03.03	**Employ organization and design principles to sort and group information used in the IT industry.**
ITC03.03.01	Demonstrate the use of information organization principles.
Sample Indicators	Demonstrate knowledge of group support technology for common knowledge requirements.
	Demonstrate knowledge of the information analysis process.
	Demonstrate knowledge of Information Technology solutions.
	Demonstrate knowledge of methods for achieving productivity in knowledge work.
ITC03.03.02	Demonstrate the use of design and color principles.

Cluster Topic ITC04	**INFORMATION TECHNOLOGY APPLICATIONS:** *Use information technology tools specific to the career cluster to access, manage, integrate, and create information.*
	No additional statements in this topic beyond those found in the Essential Knowledge and Skills Chart.

Cluster Topic ITC05	**SYSTEMS:** *Understand roles within teams, work units, departments, organizations, inter-organizational systems, and the larger environment. Identify how key organizational systems affect organizational performance and the quality of products and services. Understand global context of industries and careers.*
ITC05.01	**Analyze and summarize the use of IT in business to enhance effectiveness.**
ITC05.01.01	Integrate IT into various types of business models.

Sample Indicators	Determine how business activities interface with data processing functions.
	Differentiate between the role of information systems within a company and their role in a global environment.
	Measure increases in productivity realized by the implementation of information systems.

ITC05.02   Implement cross-functional teams to achieve IT project goals.

ITC05.02.01	Summarize the importance of cross-functional teams in achieving IT project goals.
Sample Indicators	Consider the benefits of using a cross-functional team in policy and procedure development.
	Identify desired group and team behavior in an IT context.
	Explain technical concepts to various audiences in non-technical terms.
ITC05.02.02	Describe strategies for maximizing productivity in a high tech environment.

ITC05.03   Employ project management knowledge to oversee IT projects.

ITC05.03.01	Implement project methodologies to manage information system projects.
Sample Indicators	Define the project's contribution to business needs.
	Define the scope of the project.
	Identify stakeholders and decision makers.
	Identify escalation procedures.
	Develop task list (work breakdown structures).
	Evaluate project requirements.
	Identify required resources and budget.
	Estimate time requirements.
	Develop initial project management flowchart.
	Identify interdependencies.
	Identify critical milestones.
	Evaluate risks.
	Prepare contingency plan.
	Manage the change control process.
	Track critical milestones.
	Participate in project phase review.
	Report project status.
	Utilize project management software.
	Develop a method of evaluation.
ITC05.03.02	Define scope of work to achieve individual and group goals.
Sample Indicators	Assess the task's contribution to overall business needs.
	Identify size and specifics of the task.
	Formulate task sequence.
	Plan multiple tasks simultaneously.
	Identify potential problems.
	Develop contingency plans.
ITC05.03.03	Develop time and activity plans to achieve objectives.
Sample Indicators	Coordinate plan with team, cross-functional groups, or individuals.
	Formulate a task strategy.
	Prioritize tasks according to business needs.
	Manage multiple tasks simultaneously.
	Devise plan of action.

Cluster Topic ITC06	**SAFETY, HEALTH AND ENVIRONMENTAL:** *Understand the importance of health, safety, and environmental management systems in organizations and their importance to organizational performance and regulatory compliance. Follow organizational policies and procedures and contribute to continuous improvement in performance and compliance.*
	No additional statements in this topic beyond those found in the Essential Knowledge and Skills Chart.

Cluster Topic ITC07	**LEADERSHIP AND TEAMWORK:** *Use leadership and teamwork skills in collaborating with others to accomplish organizational goals and objectives.*
	No additional statements in this topic beyond those found in the Essential Knowledge and Skills Chart.

Cluster Topic ITC08	**ETHICS AND LEGAL RESPONSIBILITIES:** *Know and understand the importance of professional ethics and legal responsibilities.*
ITC08.01	**Apply standard practices and behaviors that meet legal and ethical responsibilities and exhibit positive cyber-citizenry to understand legal issues faced by IT professionals.**
ITC08.01.01	Explain legal issues faced by IT professionals.
Sample Indicators	Demonstrate knowledge of the legal issues that face Information Technology professionals.
	Identify issues and trends affecting computers and information privacy.
	Explain legal issues involved in a company security policy.
	Identify legal issues involved concerning a security breach.
ITC08.01.02	Summarize the rights and responsibilities of IT workers.
ITC08.01.03	Identify ethical issues common to the IT field.

Cluster Topic ITC09	**EMPLOYABILITY AND CAREER DEVELOPMENT:** *Know and understand the importance of employability skills. Explore, plan, and effectively manage careers. Know and understand the importance of entrepreneurship skills.*
ITC09.01	**Identify and explain the implications IT has on business transformation and development to demonstrate an understanding of the impact on business.**
ITC09.01.01	Demonstrate understanding of the impact of IT on businesses.
Sample Indicators	Demonstrate knowledge of how both PCs and larger computer systems impact people and are used in business/industry/government and other institutions.
	Demonstrate knowledge of the impact of computers on career pathways in business/industry (e.g., how computers have eliminated and created jobs).
	Demonstrate knowledge of the impact of computers on access to information and information exchange worldwide.
	Demonstrate knowledge of ethical issues that have surfaced in the information age.

Cluster Topic ITC10	**TECHNICAL SKILLS:** *Use the technical knowledge and skills required to pursue the targeted careers for all pathways in the career cluster, including knowledge of design, operation, and maintenance of technological systems critical to the career cluster.*

ITC10.01	**Demonstrate knowledge of the hardware components associated with information systems.**
ITC10.01.01	Explain the fundamentals of operating systems.
Sample Indicators	Identify major operating system fundamentals and components.
ITC10.01.02	Explain the role of number systems in information systems.
Sample Indicators	Identify the role the binary and hexadecimal system in information systems.
	Demonstrate knowledge of number systems and internal data representation.
ITC10.01.03	Identify computer classifications and hardware.
Sample Indicators	Identify major hardware components and their functions.
	Identify the hardware associated with telecommunications functions.
	Identify types of computer storage devices.
ITC10.01.04	Describe elements and types of information processing.
Sample Indicators	Identify the elements of the information processing cycle (i.e., input, process, output, and storage).
	Identify types of processing (e.g., batch, interactive, event-driven, object-oriented).
ITC10.01.05	Use available reference tools as appropriate.
Sample Indicators	Access needed information using company and manufacturers' references (e.g., procedural manuals, documentation, standards, work flowcharts).
ITC10.01.06	Describe the function of CPUs.
ITC10.02	**Compare classes of software associated with the development and maintenance information systems to develop software and maintain computer systems.**
ITC10.02.01	Explain the key functions and applications of software.
Sample Indicators	Demonstrate knowledge of the key functions of systems software.
	Demonstrate knowledge of widely used software applications (e.g., word processing, database management, spreadsheet development).
	Demonstrate knowledge of the function and operation of compilers and interpreters.
ITC10.02.02	Describe the range of languages used in software development.
Sample Indicators	Demonstrate knowledge of the range of languages used in software development.
ITC10.02.03	Summarize how data is organized in software development.
Sample Indicators	Demonstrate knowledge of how data is organized in software development.
ITC10.02.04	Explain new and emerging classes of software.
Sample Indicators	Identify new and emerging classes of software.
ITC10.03	**Identify and compare new IT trends and technologies to build an understanding of their potential influence on IT practices.**
ITC10.03.01	Explain measurement techniques for increased productivity due to information support implementation.
Sample Indicators	Measure increases in productivity realized by the implementation of information systems.
ITC10.03.02	Identify new IT technologies.
Sample Indicators	Identify new technologies relevant to information technology.

	Assess the importance of new technologies to future developments and to future knowledge worker productivity.
	Identify new and emerging drivers and inhibitors of Information Technology change.
ITC10.03.03	Assess the potential importance and impact of new IT technologies in the future.
ITC10.04	**Summarize basic data communications components and trends to maintain and update IT systems.**
ITC10.04.01	Explain data communications procedures, equipment and media.
Sample Indicators	Demonstrate knowledge of key communications procedures.
	Demonstrate knowledge of the uses of data communication equipment.
	Demonstrate knowledge of types of communications media.
ITC10.04.02	Explain data transmission codes and protocols.
Sample Indicators	Demonstrate knowledge of data transmission codes and protocols.
ITC10.04.03	Explain the differences between local and wide area networks.
Sample Indicators	Distinguish between local area networks and wide-area networks.
ITC10.04.04	Summarize data communication trends and issues.
Sample Indicators	Identify data communication trends.
	Identify major current issues in data communications.
ITC10.05	**Demonstrate technical knowledge of the Internet to develop and maintain IT systems.**
ITC10.05.01	Describe Internet protocols.
Sample Indicators	Demonstrate knowledge of the Transmission Control Protocol/Internet Protocol (TCP/IP) suite.
	Demonstrate knowledge of management protocols, applications and procedures (e.g., SNMP, intrusion detection, and reporting issues).
	Explain the concept of routing.
ITC10.05.02	Explain Domain Name Server (DNS).
Sample Indicators	Demonstrate knowledge of the Domain Name System (DNS).
	Explain the DNS hierarchy.
	Identify elements of DNS (e.g., zones, server types).
ITC10.05.03	Summarize Internet security issues and systems available for addressing them.
Sample Indicators	Demonstrate knowledge of the Domain Name System (DNS).
	Explain the DNS hierarchy.
	Identify elements of DNS (e.g., zones, server types).
ITC10.06	**Access and use Internet services when completing IT related tasks to service and update IT systems.**
ITC10.06.01	Demonstrate the use of an Internet connection.
Sample Indicators	Configure a small home office Internet connection using cable, DSL, wireless or satellite connection.
	Test Internet connection using tools such as ping, trace route, net stat, host, dig, and nslookup.
ITC10.06.02	Troubleshoot Internet connection problems.
ITC10.06.03	Explain the components of Internet software.
Sample Indicators	Demonstrate knowledge of the components of Internet software.
ITC10.06.04	Install Internet software for use on an operating system.
Sample Indicators	Identify common browser features.

Install Internet software.

Differentiate between Web-based applications and applications installed on a local computer.

Download software upgrades and shareware from the Internet.

Unpack files using compression software.

ITC10.06.05	Describe virus protection procedures.
Sample Indicators	Demonstrate acute awareness of virus protection techniques.
	Identify types and capabilities of popular virus protection software.
	Explain spyware, adware, and malware.
	Identify how to avoid spyware, adware, and malware and how to recover from infection.

ITC10.06.06	Explain cookies and adware on an internet connected computer system.
Sample Indicators	Demonstrate knowledge of cookies and their use on an internet-connected computer system.
	Identify types and consequences of pop-ups and ad-ware.

ITC10.07	**Install and configure software programs to maintain and update IT systems.**
ITC10.07.01	Verify that hardware and software system components are compatible prior to performing installation.
Sample Indicators	Identify hardware requirements (e.g., processor, memory, disk space, communications, printers, monitors).
	Determine compatibility of hardware and software.
ITC10.07.02	Verify that software to be installed is licensed prior to performing installation.
Sample Indicators	Verify conformance to licensing agreement.
	Understand the concept of an End User License Agreement (EULA).
	Differentiate between open source and proprietary licenses.
	Explain the concept of open source.
	Identify common characteristics of open source licensing agreements, including the GNU General Public License (GPL).
ITC10.07.03	Perform installation accurately and completely, using available resources as needed.
Sample Indicators	Install given application/system software on various platforms in accordance with manufacturer's procedures.
	Disable/uninstall software that may interfere with installation of new software.
	Differentiate between procedures for an upgrade and for a new installation.
	Differentiate between stand-alone and network installation procedures.
	Select appropriate installation options (e.g., default, customized).
	Configure software to appropriate operating system settings.
	Configure macros, tools, and packages to accomplish simple organizational and personal tasks.
	Convert data files if required.
	Verify software installation and operation.
ITC10.07.04	Resolve problems with installation if they occur.
Sample Indicators	Troubleshoot unexpected results.
	Access needed help using manufacturers' technical help lines or Internet sites.
	Formulate new installation procedure if needed.
ITC10.07.05	Perform customization as requested.
Sample Indicators	Customize software to meet user preferences.

ITC10.07.06	Document procedures, using clear and effective notes, for future use.
Sample Indicators	Document step-by-step installation and configuration procedures.

ITC10.08	**Demonstrate knowledge of Web page basics to build an understanding of Web page design and functioning.**
ITC10.08.01	Explain the features and functions of Web browsing software.
Sample Indicators	Demonstrate knowledge of the role of browsers in reading files on the World Wide Web (text-only, hypertext).
	Identify how different browsers affect the look of a web page.
	Demonstrate knowledge of the characteristics and uses of plug-ins.
ITC10.08.02	Explain the features and functions of Web page design software.
Sample Indicators	Compare/contrast the features and functions of software editors available for designing web pages.
ITC10.08.03	Compare and contrast clients and servers.
Sample Indicators	Differentiate between a client and a server.
	Explain how traditional and modern Internet clients exploit the client/server relationship.
ITC10.08.04	Describe how bandwidth affects data transmission and on-screen image.
Sample Indicators	Demonstrate knowledge of how bandwidths affect data transmission and on-screen image.
ITC10.08.05	Compare the benefits of internal and external Web hosting.
Sample Indicators	Compare the advantages and disadvantages of internal external web hosting.

ITC10.09	**Employ IT knowledge and procedures when configuring or modifying an operating system to ensure optimal system functioning.**
ITC10.09.01	Configure/modify system as needed.
Sample Indicators	Secure needed supplies and resources.
	Review automated scheduling software.
	Identify data requirements.
	Identify scheduling priority in programming.
	Build system software command structures using operating system macro facilities for computer systems.
ITC10.09.02	Use operating system principles to ensure optimal system function.
Sample Indicators	Apply basic commands of operating system software.
	Apply appropriate file and disk management techniques.
	Employ desktop operating skills.
	Handle materials and equipment in a responsible manner.
	Follow power-up and log-on procedures.
	Interact with/respond to system messages using console device.
	Run applications/jobs in accordance with processing procedures.
	Follow log-off and power-down procedure(s).
ITC10.09.03	Use available reference tools as appropriate.
Sample Indicators	Access needed information using appropriate reference materials.
ITC10.09.04	Document procedures and actions.
Sample Indicators	Develop audit trails.
ITC10.09.05	Configure systems to provide optimal system interfaces.

ITC10.10	**Perform standard computer backup procedures to protect IT information.**

ITC10.10.01	Explain the need for regular backup procedures.
Sample Indicators	Recognize the need for regular backup procedures.
ITC10.10.02	Configure, perform and maintain backup procedures.
Sample Indicators	Load backup software.
	Load compression drive backup software.
	Install surge suppression protection.
	Identify battery backup equipment.
	Maintain battery backup system.
	Identify hot and warm site backup concepts.

ITC10.11	**Recognize and analyze potential IT security threats to develop and maintain security requirements.**
ITC10.11.01	Describe potential security threats to information systems.
ITC10.11.02	Identify the range of security needs and the problems that can occur due to security lapses.
ITC10.11.03	Assess security threats.
Sample Indicators	Maximize threat reduction.
	Assess exposure to security issues.
	Implement countermeasures.
	Ensure compliance with security rules, regulations, and codes.
	Demonstrate knowledge of virus protection strategy.
	Implement security procedures in accordance with business ethics.
ITC10.11.04	Develop plans to address security threats.
ITC10.11.05	Implement plans to address security procedures.
Sample Indicators	Maintain confidentiality.
	Load virus detection and protection software.
	Identify sources of virus infections.
	Remove viruses.
	Report viruses in compliance with company standards.
	Implement backup and recovery procedures.
	Follow disaster plan.
	Provide for user authentication and restricted access (e.g., assign passwords, access level).
ITC10.11.06	Document security procedures.

ITC10.12	**Maintain computer systems to ensure optimal IT system functioning.**
ITC10.12.01	Implement queries and reports to provide access to critical system information.
Sample Indicators	Create a query to extract information from a file.
	Create a query to extract information from multiple files.
	Create reports from queries.
	Create and use logical files.
	Develop a display screen for use with high-level language program.
	Access needed information using appropriate reference materials.
ITC10.12.02	Ensure that system is functioning optimally.
Sample Indicators	Monitor system status and performance.
	Run diagnostics.
	Respond to system messages.

	Perform preventive maintenance procedures on computer and peripheral devices.
	Handle materials and equipment in a responsible manner.
	Optimize windows environment to maximize performance of desktop resources.
	Review automated scheduling software.
ITC10.12.03	Fix and document system problems.
Sample Indicators	Fix recoverable problems.
	Restore system.
	Document computer system malfunction(s).
	Document software malfunction(s).
ITC10.12.04	Configure systems to provide optimal system interfaces.
Sample Indicators	Define hardware-software interface issues for a computer system.
	Identify standards and issues related to I/O programming and design of I/O interfaces.
	Interface peripheral devices/controllers in the computer system (e.g., software and hardware interrupts, exceptions, Direct Memory Addressing [DMA], bus structures).
	Apply concepts of privileged instructions and protected mode programming.
	Configure peripheral device drivers (e.g., disk, display, printer, modem, keyboard, mouse, network).
	Apply advanced I/O concepts (e.g., disk caching, data compression, extended memory, magnetic disk/CD-ROM storage and formats).
	Allocate disk space, non-sharable resources, and I/O devices.

ITC10.13 **Provide IT support and training to maintain proper network functioning.**

ITC10.13.01	Provide Help Desk service to computer users within the organization.
Sample Indicators	Operate help desk.
	Employ desktop productivity tools.
	Support computer users.
ITC10.13.02	Provide training for basic computer use within the organization.
Sample Indicators	Train computer users.

ITC10.14 **Identify and describe quality assurance concepts to develop an understanding of the requirements for quality IT products/services.**

ITC10.14.01	Explain the history and standards of key quality management initiatives.
Sample Indicators	Demonstrate knowledge of the historical evolution of quality assurance/total quality management (e.g., Deming, ISO 9000).
	Demonstrate knowledge of changes brought about by quality leaders in the world.
	Demonstrate knowledge of the ISO 9000 process.
	Demonstrate knowledge of the standards/requirements for the Baldridge award.
	Demonstrate knowledge of successful efforts by industry to improve quality and/or reduce costs.
ITC10.14.02	Explain the terminology, role and benefits of quality within an organization.
Sample Indicators	Demonstrate knowledge of quality management terminology.
	Identify the role of quality within the organization.
	Identify the features and benefits of quality planning.
ITC10.14.03	Summarize the elements of a quality management system.

Sample Indicators	Demonstrate knowledge of the control devices used in functional areas (e.g., SPC, equipment).
Demonstrate knowledge of the relationship among organizational structures, policies, procedures, and quality assurance.
Identify internal and external customers.
Differentiate between prevention and detection.
Differentiate between variable and attribute data.
Identify types of control charts.
Demonstrate knowledge of how statistical techniques used to control quality (e.g., SPC, DOE, CR).
ITC10.15	**Describe the use of computer forensics to prevent and solve information technology crimes and security breaches.**
ITC10.15.01	Describe the role of computer forensic investigators.
Sample Indicators	Define computer forensics.
List some of the basic skills and knowledge a computer forensics specialist should possess.
Identify the circumstances under which computer forensics evidence is typically used, who typically uses such evidence, and how it is used.
ITC10.15.02	Demonstrate the effective use of basic computer applications relating to forensics investigations.
Sample Indicators	Identify and attempt to retrieve possible evidence that may exist on a computer system.
List what should and should not be done with the computer and evidence during an investigation.
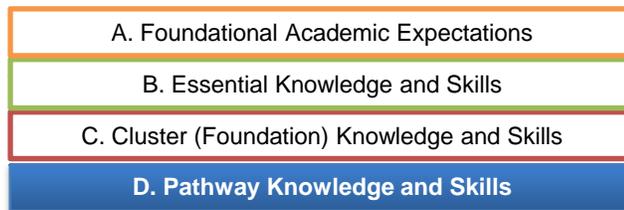| ITC10.15.03	Identify criminal activity in relationship to cyber crime, the Internet, and Internet trafficking.
Sample Indicators	List common internet crimes.
List some prevention actions related to cyber crime.
Describe techniques to identify criminal activity.
Identify how one files a complaint if a cyber crime is suspected or has occurred.

D. PATHWAY KNOWLEDGE AND SKILLS

The following knowledge and skill statements apply to all careers in the Programming and Software Development Pathway.

A. Foundational Academic Expectations

B. Essential Knowledge and Skills

C. Cluster (Foundation) Knowledge and Skills

D. Pathway Knowledge and Skills

Pathway Topic ITPD01	**PROGRAMMING AND SOFTWARE DEVELOPMENT**
ITPD01.01	**Identify and analyze customer software needs and requirements to guide programming and software development.**
ITPD01.01.01	Gather data to identify customer requirements.

Sample Indicators	Gather information using interviewing strategies.
	Identify input and output requirements.
	Identify system processing requirements.
	Clarify specifications using questioning techniques.
	Identify hardware, networking, and software system functional requirements.
	Demonstrate knowledge of nonfunctional requirements (e.g., security, integrity response time, reliability, support, and documentation).

ITPD01.01.02   Conduct needs analysis.
Sample Indicators
Gather information on problems from users.
Perform workflow analysis to determine user needs.
Analyze existing procedures.
Define business problem to be solved by the application.

ITPD01.01.03   Develop software requirements and specifications.
Demonstrate knowledge of the use, structure, and contents of a requirements specification document.
Sample Indicators
Define system and software requirements.
Develop informal specifications.
Develop formal specification.
Resolve conflicting requirements.
Review and verify specification with customer.

ITPD01.01.04   Analyze requirements/specifications using current approaches.
Demonstrate knowledge of how to use software methodologies to analyze a real-world problem.
Sample Indicators
Identify constraints.
Demonstrate knowledge of modeling and analyzing functional requirements (e.g., dataflow diagrams, process specifications, and a data dictionary).
Demonstrate knowledge of modeling and analyzing data requirements (e.g., Jackson diagrams, entity relationship diagrams, and relations).

ITPD01.01.05   Use available reference tools as appropriate.
Access needed information using company and manufacturers' references (e.g., procedural manuals, documentation, standards, work flowcharts).
Sample Indicators

ITPD01.02   **Create and use IT-based strategies and project plans when solving specific problems to deliver a product that meets customer specifications.**

ITPD01.02.01   Define scope of work for the programming project.
Sample Indicators   Define scope of work to meet customer needs.

Demonstrate knowledge of the key functions and subsystems of the software product.
Demonstrate knowledge of software development process and issues.
Demonstrate knowledge of the system life-cycle approach.

ITPD01.02.02   Utilize interpersonal skills necessary to work on a software development team.
Sample Indicators   Identify resources and risks.

Demonstrate knowledge of cross-functional team structures and team members' roles.

ITPD01.02.03   Design project plan.
Demonstrate knowledge of project budgeting, scheduling, and control issues related to software development.
Sample Indicators
Demonstrate knowledge of software development methodology.
Develop implementation plan.

ITPD01.03	**Identify and analyze system and software requirements to ensure maximum operating efficiency.**

ITPD01.03.01   Identify the potential importance and impact of new IT technologies.
Sample Indicators
    Identify new technologies relevant to information technology.
    Assess the importance of new technologies to future developments.
    Identify system processing requirements.
    Identify data communication trends and major current issues.

ITPD01.03.02   Assess the potential importance and impact of new IT technologies.

ITPD01.03.03   Explain new and emerging classes of software.
Sample Indicators
    Identify new and emerging classes of software.
    Determine compatibility of hardware and software.

ITPD01.03.04   Summarize elements and types of information processing.
Sample Indicators   Identify the elements of the information processing cycle (i.e., input, process, output, and storage).

ITPD01.03.05   Explain measurement techniques for increased productivity due to information systems implementation.
Sample Indicators   Identify metrics for measurements.

    Measure increases in productivity realized by the implementation of information systems.

    Identify new and emerging drivers and inhibitors of information technology change.

ITPD01.04	**Demonstrate the effective use of tools for software development to develop software applications.**

ITPD01.04.01   Employ tools in developing software applications.
Sample Indicators
    Demonstrate knowledge of software development environment.
    Use prototyping techniques.
    Use appropriate Configuration Management tools.
    Use appropriate issues tracking tools.
    Demonstrate knowledge of reuse and components.

ITPD01.04.02   Apply language specific programming tools/techniques.
Sample Indicators
    Develop programs using appropriate language.
    Use appropriate development environment for the selected language (e.g., compilers, debuggers, test generation, static analyzer, etc.).
    Use user interface development tools.

ITPD01.04.03   Demonstrate use of computer-aided software engineering (CASE) tools.
Sample Indicators
    Use appropriate requirement analysis tools.
    Use appropriate modeling and analysis tools.
    Use requirement tracking tools.
    Demonstrate knowledge of software reuse, design pattern, and components.

ITPD01.05	**Design a software application using the software development process to deliver a product to the customer.**

ITPD01.05.01   Describe software development processes and methodology.
Sample Indicators
    Demonstrate knowledge of the information system life cycle.
    Demonstrate knowledge of system analysis issues related to design, testing, implementation, and maintenance.
    Record and analyze process.
    Identify the use of program design tools in a software development process.

	Identify roles on team members/customers in the software development process.
	Identify current information life cycle models.
ITPD01.05.02	Create design specifications for a computer application.
ITPD01.05.03	Describe trade-offs involved in design choices.
ITPD01.05.04	Summarize the use of the principles of effective information management, information organization and information-retrieval skills when designing a software application.
ITPD01.05.05	Explain computing/networking hardware and software architecture.
ITPD01.06	**Produce (code) a computer application to demonstrate proficiency in developing an application using the appropriate programming language.**
ITPD01.06.01	Explain programming language concepts.
Sample Indicators	Demonstrate knowledge of the hardware-software connections.
	Demonstrate knowledge of the concepts of data and procedural representations.
	Demonstrate knowledge of the basic principles for analyzing a programming language.
	Demonstrate knowledge of the basics of structured, object-oriented language.
	Demonstrate knowledge of how a programming language can support multitasking and exception-handling.
ITPD01.06.02	Demonstrate proficiency in developing an application using an appropriate programming language.
Sample Indicators	Demonstrate knowledge of current key programming languages and the environment they are used in.
	Translate data structure and program design into code in an appropriate language.
	Demonstrate knowledge of key constructs and commands specific to a language.
ITPD01.06.03	Describe the range of languages used in software development.
Sample Indicators	Demonstrate knowledge of the range of languages used in software development.
ITPD01.06.04	Summarize program development methodology.
Sample Indicators	Demonstrate knowledge of how to resolve program implementation issues (e.g., debugging, documentation, auditing).
	Demonstrate knowledge of software development issues (e.g., audit ability, correctness, reliability, and productivity).
	Demonstrate knowledge of code analysis issues related to design, testing, implementation, and maintenance.
	Demonstrate knowledge of how to design and implement programs in a top-down manner.
	Demonstrate knowledge of how to translate algorithmic and modular designs to develop a program.
	Demonstrate knowledge of structured/modular programming.
	Demonstrate knowledge of how programming control structures are used to verify correctness.
	Use code development tools (e.g. debugger, integrated development environments).
ITPD01.06.05	Explain basic software systems implementation.
Sample Indicators	Use appropriate programming language.

Analyze and prepare logic using program flowchart.

Analyze and prepare logic using at least one alternative to flowcharting such as pseudocoding.

Review design (e.g., peer and/or user walkthrough).

Compile and debug code.

Prepare code documentation.

Prepare unit testing plan.

Conduct unit testing and bug fixes.

ITPD01.06.06	Develop software requirements/specifications.
Sample Indicators	Access needed information using company and manufacturers' references (e.g., procedural manuals, documentation, standards, word flowcharts).
	Divide design specifications into logical process blocks.
	Identify parameters.
	Follow specifications or drawings.
	Record process (e.g., using flowchart, step-by-step narrative).
	Record data.
ITPD01.06.07	Resolve problems with integration.
Sample Indicators	Troubleshoot unexpected results.
	Fix code.

ITPD01.07   Implement software testing procedures to ensure quality products.

ITPD01.07.01	Develop a software test plan.
Sample Indicators	Access needed information using appropriate reference materials.
	Define test procedures.
	Analyze requirement and design specifications.
	Development test cases using requirements and design specification.
ITPD01.07.02	Perform testing and validation.
Sample Indicators	Perform integration testing.
	Perform regression testing.
	Help with user-acceptance test.
	Validate user documentation.
ITPD01.07.03	Document test results.
Sample Indicators	Document errors discovered.
	Perform defect tracking.
	Document discovered errors.
ITPD01.07.04	Develop software testing audit trails.
Sample Indicators	Record error correction procedures and actions.

ITPD01.08   Perform quality assurance tasks to produce quality products.

ITPD01.08.01	Summarize software quality assurance (QA) procedures.
Sample Indicators	Demonstrate knowledge of Software QA process.
	Demonstrate knowledge of the standards/requirements for Software QA.
	Develop team relationships to support Software QA tasks.
ITPD01.08.02	Perform software quality assurance tasks to produce a quality software product.
Sample Indicators	Identify standards and issues related to I/O programming and design of I/O interfaces.
	Use customer satisfaction in determining product characteristics (e.g., cost, user-friendliness).

Recognize the relationship between dependability, functionality, ease of use, etc.

Conduct code walkthrough and/or inspection.

Follow established procedures for testing, identifying problems, and tracking resolutions.

ITPD01.09 **Perform maintenance and customer support functions to maintain software applications.**

ITPD01.09.01 Analyze software technical support needs.
Sample Indicators Identify maintenance and support requirements.
Apply information and data analysis techniques.
Define scope of work to meet customer support needs.

ITPD01.09.02 Perform customer service.
Sample Indicators Access needed information using appropriate reference materials.
Provide help to first line user-support personnel to answer user questions.
Provide troubleshooting for software.
Perform system-tuning function.
Diagnose problems within system.
Perform technical functions required by customer/user.
Communicate and document technical support provided.

ITPD01.09.03 Perform software maintenance activities.

Sample Indicators Following organizational procedural to communicate and document maintenance tasks.
Identify and analyze problem.
Analyze and propose solutions.
Implement solutions in code and documentation.
Release software and documentation updates according to procedures.

ITPD01.10 **Develop and maintain a database to store information.**

ITPD01.10.01 Explain database development processes.
Identify appropriate database type based on customer requirements, availability of
Sample Indicators software and hardware resources, and distribution specifications, etc.
Apply information and data analysis specifications to create a database model using techniques such as (e.g. -Entity Relationship Diagramming).
Analyze and normalize the developed database model looking for and resolving potential problems.
Analyze the security needs for the database.

ITPD01.10.02 Create, populate, and maintain a database.

Create a database from model specifications using both program code and Graphic User
Sample Indicators Interface (GUI) processes when provided by the database software.
Verify that all possible security safeguards are in place.
Populate the database created with test data.

Perform database queries to analyze database functionality and diagnose problems.
Perform database troubleshooting and system-tuning functions.
Perform technical functions required by customer/user.
Communicate and document technical support provided.
Perform standard maintenance on the database.
Release software and documentation updates according to procedures.

ITPD01.10.03 Perform database interfacing with web applications.
Sample Indicators Develop scripts and forms that permit access via websites to the database.

Identify and analyze potential security problems for web access to the database.

Propose security solutions to web-based security problems.

Implement solutions in code and documentation.

Information Technology Cluster Statements (Knowledge and Skill and Performance Elements); Information Technology Career Cluster Cluster Knowledge and Skill Statements (Foundation); Information Technology Cluster Information Support and Services Pathway Knowledge and Skill Statements; Information Technology Cluster Network Systems Pathway Knowledge and Skill Statements; Information Technology Cluster Web and Digital Communication Pathway Knowledge and Skill Statements; Information Technology Cluster Programming and Software Development Pathway Knowledge and Skill Statements are based in part on skill statements developed by Education Development Center, Inc., ITWorks! Ohio, the National Workforce Center for Emerging Technologies (formerly the Northwest Center for Emerging Technologies) and the World Organization of Webmasters (WOW).