Information Technology Career Cluster
Embedded Computing
Course Number: 11.42700

Course Description:
The demand for programming (software development) has gone well beyond desktop computers and the web, into a ubiquitous world of personal devices, smart cars, intelligent factories, and even more. These systems interact with us directly, as well as with each other. This course will focus on the interaction of programming and devices, using data from various sensors and sources in order to make decisions, take actions, and more. A common industry term to describe this work is Internet of Things. Students will show first-hand how programming and machines interact to accomplish common and essential tasks throughout our society.

Embedded Computing is the third course in the Internet of Things pathway. Students enrolled in this course should have successfully completed Introduction to Digital Technology and Computer Science Principles. After mastery of the standards in this course, students should be prepared to earn an industry-recognized credential in this career area.

Course Standard 1

IT-EP-1
The following standard is included in all CTAE courses adopted for the Career Cluster/Pathways. Teachers should incorporate the elements of this standard into lesson plans during the course. The topics listed for each element of the standard may be addressed in differentiated instruction matching the content of each course. These elements may also be addressed with specific lessons from a variety of resources. This content is not to be treated as a unit or separate body of knowledge but rather integrated into class activities as applications of the concept.

Standard: Demonstrate employability skills required by business and industry.
The following elements should be integrated throughout the content of this course.
1.1   Communicate effectively through writing, speaking, listening, reading, and interpersonal abilities.

Person-to-Person Etiquette	Telephone and Email Etiquette	Cell Phone and Internet Etiquette	Communicating At Work	Listening
Interacting with Your Boss	Telephone Conversations	Using Blogs	Improving Communication Skills	Reasons, Benefits, and Barriers
Interacting with Subordinates	Barriers to Phone conversations	Using Social Media	Effective Oral Communication	Listening Strategies
Interacting with Co-workers	Making and Returning Calls		Effective Written Communication	Ways We Filter What We Hear
Interacting with Suppliers	Making Cold Calls		Effective Nonverbal Skills	Developing a Listening Attitude
	Handling Conference Calls		Effective Word Use	Show You Are Listening
	Handling Unsolicited Calls		Giving and Receiving Feedback	Asking Questions
				Obtaining Feedback
				Getting Others to Listen

Nonverbal Communication	Written Communication	Speaking	Applications and Effective Résumés
Communicating Nonverbally	Writing Documents	Using Language Carefully	Completing a Job Application
Reading Body Language and mixed Messages	Constructive Criticism in Writing	One-on-One Conversations	Writing a Cover Letter
Matching Verbal and Nonverbal communication		Small Group Communication	Things to Include in a Résumé
Improving Nonverbal Indicators		Large Group Communication	Selling Yourself in a Résumé
Nonverbal Feedback		Making Speeches	Terms to Use in a Résumé
Showing Confidence Nonverbally		Involving the Audience	Describing Your Job Strengths
Showing Assertiveness		Answering Questions	Organizing Your Résumé
		Visual and Media Aids	Writing an Electronic Résumé
		Errors in Presentation	Dressing Up Your Résumé

1.2 Demonstrate creativity by asking challenging questions and applying innovative procedures and methods.

Teamwork and Problem Solving	Meeting Etiquette
Thinking Creatively	Preparation and Participation in Meetings
Taking Risks	Conducting Two-Person or Large Group Meetings
Building Team Communication	Inviting and Introducing Speakers
	Facilitating Discussions and Closing
	Preparing Visual Aids
	Virtual Meetings

1.3 Exhibit critical thinking and problem solving skills to locate, analyze and apply information in career planning and employment situations.

Problem Solving	Customer Service	The Application Process	Interviewing Skills	Finding the Right Job
Transferable Job Skills	Gaining Trust and Interacting with Customers	Providing Information, Accuracy and Double Checking	Preparing for an Interview	Locating Jobs and Networking
Becoming a Problem Solver	Learning and Giving Customers What They Want	Online Application Process	Questions to Ask in an Interview	Job Shopping Online
Identifying a Problem	Keeping Customers Coming Back	Following Up After Submitting an Application	Things to Include in a Career Portfolio	Job Search Websites
Becoming a Critical Thinker	Seeing the Customer's Point	Effective Résumés:	Traits Employers are Seeking	Participation in Job Fairs
Managing	Selling Yourself and the Company	Matching Your Talents to a Job	Considerations Before Taking a Job	Searching the Classified Ads
	Handling Customer Complaints	When a Résumé Should be Used		Using Employment Agencies
	Strategies for Customer Service			Landing an Internship
				Staying Motivated to Search

1.4   Model work readiness traits required for success in the workplace including integrity, honesty, accountability, punctuality, time management, and respect for diversity.

Workplace Ethics	Personal Characteristics	Employer Expectations	Business Etiquette	Communicating at Work
Demonstrating Good Work Ethic	Demonstrating a Good Attitude	Behaviors Employers Expect	Language and Behavior	Handling Anger
Behaving Appropriately	Gaining and Showing Respect	Objectionable Behaviors	Keeping Information Confidential	Dealing with Difficult Coworkers
Maintaining Honesty	Demonstrating Responsibility	Establishing Credibility	Avoiding Gossip	Dealing with a Difficult Boss
Playing Fair	Showing Dependability	Demonstrating Your Skills	Appropriate Work Email	Dealing with Difficult Customers
Using Ethical Language	Being Courteous	Building Work Relationships	Cell Phone Etiquette	Dealing with Conflict
Showing Responsibility	Gaining Coworkers' Trust		Appropriate Work Texting	
Reducing Harassment	Persevering		Understanding Copyright	
Respecting Diversity	Handling Criticism		Social Networking	
Making Truthfulness a Habit	Showing Professionalism			
Leaving a Job Ethically				

1.5   Apply the appropriate skill sets to be productive in a changing, technological, diverse workplace to be able to work independently and apply team work skills.

Expected Work Traits	Teamwork	Time Management
Demonstrating Responsibility	Teamwork Skills	Managing Time
Dealing with Information Overload	Reasons Companies Use Teams	Putting First Things First
Transferable Job Skills	Decisions Teams Make	Juggling Many Priorities
Managing Change	Team Responsibilities	Overcoming Procrastination
Adopting a New Technology	Problems That Affect Teams	Organizing Workspace and T=asks
	Expressing Yourself on a Team	Staying Organized
	Giving and Receiving Constructive Criticism	Finding More Time
		Managing Projects
		Prioritizing Personal and Work Life

1.6   Present a professional image through appearance, behavior and language.

On-the-Job Etiquette	Person-to-Person Etiquette	Communication Etiquette	Presenting Yourself
Using Professional Manners	Meeting Business Acquaintances	Creating a Good Impression	Looking Professional
Introducing People	Meeting People for the First Time	Keeping Phone Calls Professional	Dressing for Success
Appropriate Dress	Showing Politeness	Proper Use of Work Email	Showing a Professional Attitude
Business Meal Functions		Proper Use of Cell Phone	Using Good Posture
Behavior at Work Parties		Proper Use in Texting	Presenting Yourself to Associates
Behavior at Conventions			Accepting Criticism

International Etiquette			Demonstrating Leadership
Cross-Cultural Etiquette			
Working in a Cubicle			

Course Standard 2

IT-EP-2
Explain Embedded Computing (EC) and the Internet of Things (IoT).
- 2.1 Define the basic terminology of EC/IoT.
- 2.2 Create a glossary of basic EC/IoT terminology.
- 2.3 Compare and contrast microprocessors and microcontrollers.
- 2.4 Research and report on popular microcontrollers and EC/IoT platforms (e.g., Arduino, Raspberry Pi, spark.io, BASIC Stamp, Espruino, LightBlue Bean, LittleBits Arduino).

Course Standard 3

IT-EP-3
Demonstrate a working knowledge of basic networking protocols for industry, homes, and the internet including speed, power requirements, and popularity in industry and personal devices.
- 3.1 Compare and contrast Radio Frequency (RF) networking technologies, (e.g., Wi-Fi, bluetooth, BLE, Zigbee, Zwave) including speed, power requirements, and popularity in industry and personal devices.
- 3.2 Explain advantages and disadvantages of wireless networking compared to wired networking.
- 3.3 Demonstrate a working knowledge of serial networking technologies used by microcontrollers (e.g., I2C, RS-232, RS-422, RS-485, SPI, master/slave).

Course Standard 4

IT-EP-4
Develop and investigate interfacing circuits.
- 4.1 Explain the difference between a source and a sink.
- 4.2 Identify the differences between analog and digital circuits.
- 4.3 Describe the function of a pull-up resistor.
- 4.4 Calculate the current draw of series and parallel circuits.
- 4.5 Build an operational LED circuit with a switch to turn it on/off, giving examples of why this is helpful in an IoT scenario.
- 4.6 Research and report the current and voltage I/O limitations of the embedded platform/microcontroller used in the class.
- 4.7 Discuss the characteristics of digital input and output ports on a microcontroller.
- 4.8 Demonstrate an understanding of analog to digital (ADC) and digital to analog ports (DAC) on a microcontroller.

Course Standard 5

IT-EP-5
Classify and categorize multiple kinds of sensors.
- 5.1 Classify and explain examples of the following kinds of sensors: temperature, distance, light, sound, contact, pressure, position – GPS (Global Positioning System), encoders, potentiometer, gyro, and accelerometer.
- 5.2 Explain the basic functioning principles of the sensors above and their possible uses.

Course Standard 6

IT-EP-6
Manipulate, connect, and examine performance aspects of motors.
- 6.1 Demonstrate an understanding of stepper motors.
- 6.2 Explain how a servo motor operates.
- 6.3 Describe the operation of brushed motor controller.
- 6.4 Explain how a brushless motor controller works.
- 6.5 Demonstrate an understanding of pulse width modulation (PWM) control of motors.
- 6.6 Select the proper motor and controller for a given task, including exceptions that require a different action (if/then scenarios).

Course Standard 7

IT-EP-7
Investigate and draw connections within the context of programming as it relates to Embedded Computing/Internet of Things.
- 7.1 Identify and utilize popular programming languages used for EC/IoT applications.
- 7.2 Analyze the process of software development for an embedded application.
- 7.3 Compare and contrast interpreted and compiled applications.
- 7.4 Define real time programming and interrupt driven programming.
- 7.5 Analyze and explain when integer and floating point numbers are needed.
- 7.6 Design the use of a finite state machine using real-world examples (e.g. vending machines, assisted GPS on smartphones, various radio/connectivity states).

Course Standard 8

IT-EP-8
Interpret debugging techniques in hardware and software.
- 8.1 Gather, organize, and interpret data to identify simple bugs in EC/IoT applications.
- 8.2 Utilize proper methods for debugging, including systematically changing, then checking, one item at a time.
- 8.3 Evaluate the breakpoint, interrupt, main loop, event driven, and race condition in EC/IoT applications.
- 8.4 Prove how to debug an actual program using a debugging tool and explain the reasons behind the steps taken.

Course Standard 9

IT-EP-9
Compare, contrast, and utilize Cloud Service features.
- 9.1 Debate Security/Privacy concerns of EC/IoT applications.
- 9.2 Explore available cloud-based application program interfaces (APIs).
- 9.3 Develop an application that connects with one or more cloud-based services/storage solutions (e.g., Twitter, IFTTT [If This Then That], Dropbox, Google)

Course Standard 10

IT-EP-10
Design an embedded computing application that solves a current problem (e.g., robotics, artbotics, visual, and kinetic art).
- 10.1 Design, develop, and debug an embedded computing application interfacing to an external sensor, switch, LED, or other device.
- 10.2 Design, develop, and debug an external application on a PC or mobile device accessing data from a remote embedded computer.

Course Standard 11

IT-EP-11
Examine how related student organizations are integral parts of career and technology education courses through leadership development, school and community service projects and competitive events.
- 11.1 Explain the goals, mission, and objectives of the career-technical student organization (CTSO).
- 11.2 Explore the impact and opportunities a student organization can develop to bring business and education together in a positive working relationship through innovative leadership and career development programs.
- 11.3 Explore the local, state, and national opportunities available to students through participation in related student organization including but not limited to conferences, competitions, community service, philanthropy, and other CTSO activities.
- 11.4 Explain how participation in career and technology education student organizations can promote lifelong responsibility for community service and professional development.
- 11.5 Explore the competitive events related to the content of this course and the required competencies, skills, and knowledge for each related event for individual, team, and chapter competitions.