DIGITAL ELECTRONICS

COURSE DESCRIPTION

Digital Electronics is a course in which students will construct and test fundamental digital logic circuits such as gates, counters, oscillators, and switches. A/D and D/A convertors will be applied to signal processing. Microcontroller programs will be modified and microcontrollers applied to closed-circuit control systems. The course culminates in a group project to create a digital servo control loop. Emphasis is on hands-on activities, real-world equipment, and current technology.

It is strongly recommended that administration and guidance follow the scope and sequence and course recommendations as listed.

Recommended: Algebra I

Recommended Credits: 1

Recommended Grade Level(s): 10th, 11th or 12th

Number of Competencies: 37

DIGITAL ELECTRONICS

STANDARDS

1.0   Students will perform safety examinations and maintain safety records.

2.0   Students will demonstrate leadership, citizenship, and teamwork skills required for success in the school, community, and workplace.

3.0   Students will integrate reading, writing, math, and science skills and understand the impact of academic achievement in the work place.

4.0   Students will demonstrate the use of gates and counters in logic circuits.

5.0   Students will demonstrate the use of oscillators in logic circuits.

6.0   Students will demonstrate the functions of switches and multiplexers in signal distribution and operate them.

7.0   Students will demonstrate the functions of analog and digital convertors and operate them.

8.0   Students will program and modify microcontrollers.

DIGITAL ELECTRONICS

STANDARD 1.0

Students will perform safety examinations and maintain safety records.

LEARNING EXPECTATIONS

The student will:
1.1   Demonstrate a positive attitude regarding safety practices and issues.
1.2   Use and inspect personal protective equipment.
1.3   Inspect, maintain, and employ safe operating procedures with tools and equipment, such as hand and power tools, ladders, scaffolding, and lifting equipment.
1.4   Demonstrate continuous awareness of potential hazards to self and others and respond appropriately.
1.5   Assume responsibilities under HazCom (Hazard Communication) regulations.
1.6   Adhere to responsibilities, regulations, and Occupational Safety & Health Administration (OSHA) policies to protect coworkers and bystanders from hazards.
1.7   Adhere to responsibilities, regulations, and Occupational Safety & Health Administration (OSHA) policies regarding reporting of accidents and observed hazards, and regarding emergency response procedures.
1.8   Demonstrate appropriate related safety procedures.
1.9   Pass with 100 % accuracy a written examination relating to safety issues
1.10 Pass with 100% accuracy a performance examination relating to safety.
1.11 Maintain a portfolio record of written safety examinations and equipment examinations for which the student has passed an operational checkout by the instructor.

PERFORMANCE INDICATORS: EVIDENCE STANDARD IS MET

The student:
1.1A   Is attentive during safety discussions.
1.1B   Actively seeks information about safe procedures.
1.1C   Responds positively to instruction, advice, and correction regarding safety issues.
1.1D   Does not deliberately create or increase hazards, such as by horseplay, practical jokes, or creating distractions.
1.1E   Reports to school or work physically ready to perform to professional standards, such as rested, or not impaired by medications, drugs, alcohol, etc.
1.2   Selects, inspects, and uses the correct personal protective equipment for the assigned task.
1.3A   Inspects power tools for intact guards, shields, insulation, and other protective devices.
1.3B   Inspects extension cords for the presence of a functional ground connection, prior to use.
1.3C   Operates and maintains tools in accordance with manufacturer's instructions and as required by regulation or company policy.
1.3D   Properly places and secures ladders and scaffolding prior to use.
1.4A   Is observant of personnel and activities in the vicinity of the work area.

1.4B   Warns nearby personnel, prior to starting potentially hazardous actions.
1.5A   When asked to use a new hazardous material, retrieves MSDSs (material safety data sheets), and identifies the health hazards associated with the new material.
1.5B   Reports hazards found on the job site to the supervisor.
1.6A   Erects shields, barriers, and signage to protect coworkers and bystanders prior to starting potentially hazardous tasks.
1.6B   Provides and activates adequate ventilation equipment as required by the task.
1.7A   Reports all injuries to self to the immediate supervisor.
1.7B   Reports observed unguarded hazards to their immediate supervisor.
1.8A   Complies with personal assignments regarding emergency assignments.
1.9A   Passes with 100% accuracy a written examination relating specifically to content area.
1.10A Passes with 100% accuracy a performance examination relating specifically to welding tools, equipment and supplies.
1.11A Maintains a portfolio record of written safety examinations and equipment examinations for which the student has passed an operational checkout by the instructor.

SAMPLE PERFORMANCE TASKS

These are sample projects of the type and scale recommended to address one or more of the learning expectations for this standard. Other projects can be used at the instructor's discretion.

- Conduct a practice drill simulating a hazardous solvent spill in which an emergency action plan is to be implemented.
- Instruct a visitor to obviously approach the vicinity of a student conducting a hazardous activity and note the level of awareness demonstrated by the student.
- For a project requiring the use of ladders and/or scaffolding, note the proper placement and securing procedures followed by students.

INTEGRATION LINKAGES

Language Arts, Mathematics, Technical Algebra, Technical Geometry, Algebra, Geometry English IV: Communication for Life, SkillsUSA Technical Championships, American Welding Society (AWS), Guide for Training and Qualification of Entry Level Welder, National Center for Construction Education Research (NCCER), Secretary's Commission on Achieving Necessary Skills (SCANS), Professional Development Program, SkillsUSA

DIGITAL ELECTRONICS

STANDARD 2.0

Students will demonstrate leadership, citizenship, and teamwork skills required for success in the school, community, and workplace.

LEARNING EXPECTATIONS

The student will:
2.1 Cultivate positive leadership skills.
2.2 Participate in the student organization directly related to their program of study as an integral part of classroom instruction.
2.3 Assess situations, apply problem-solving techniques and decision-making skills within the school, community, and workplace.
2.4 Participate as a team member in a learning environment.
2.5 Respect the opinions, customs, and individual differences of others.
2.6 Build personal career development by identifying career interests, strengths, and opportunities.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:
2.1A Demonstrates character and leadership using creative-and critical-thinking skills.
2.1B Uses creative thought process by "thinking outside the box."
2.2A Relates the creed, purposes, motto, and emblem of their student organization, directly related to personal and professional development.
2.2B Plans and conducts meetings and other business according to accepted rules of parliamentary procedure.
2.3A Makes decisions and assumes responsibilities.
2.3B Analyzes a situation and uses the Professional Development Program or career technical student organization materials directly related to the student's program of study to resolve it.
2.3C Understands the importance of learning new information for both current and future problem solving and decision making.
2.4A Organizes committees and participates in functions.
2.4B Cooperates with peers to select and organize a community service project.
2.5A Researches different customs and individual differences of others.
2.5B Interacts respectfully with individuals of different cultures, gender, and backgrounds.
2.5C Resolves conflicts and differences to maintain a smooth workflow and classroom environment.
2.6A Creates personal career development by identifying career interests, strengths, and opportunities.
2.6B Identifies opportunities for career development and certification requirements.

2.6C Plans personal educational paths based on available courses and current career goals.

2.6D Creates a resumé that reflects student's skills, abilities, and interests.

SAMPLE PERFORMANCE TASKS

- Create a leadership inventory and use it to conduct a personal assessment.
- Participate in various career technical student organizations' programs and/or competitive events.
- Implement an annual program of work.
- Prepare a meeting agenda for a specific career technical student organization monthly meeting.
- Attend a professional organization meeting.
- Develop a program of study within their career opportunities.
- Participate in the American Spirit Award competition with SkillsUSA.
- Complete *Professional Development Program Level I and Level II*, SkillsUSA.

INTEGRATION LINKAGES

SkillsUSA, *Professional Development Program*; SkillsUSA; Communications and Writing Skills; Teambuilding Skills; Research; Language Arts; Sociology; Psychology; Math; Technical Math; English IV: Communication for Life; Social Studies; Problem Solving; Interpersonal Skills; Employability Skills; Critical-Thinking Skills; Secretary's Commission on Achieving Necessary Skills (SCANS); Chamber of Commerce; Colleges; Universities; Technology Centers; Secretary's Commission on Achieving Necessary Skills (SCANS)

DIGITAL ELECTRONICS

STANDARD 3.0

Students will integrate reading, writing, math, and science skills and understand the impact of academic achievement in the work place.

LEARNING EXPECTATIONS

The student will:

3.1 Assume responsibility for accomplishing classroom assignments and workplace goals within accepted time frames.

3.2 Develop advanced study skills.

3.3 Demonstrate and use written and verbal communication skills.

3.4 Read and understand technical documents such as regulations, manuals, reports, forms, graphs, charts, and tables.

3.5 Apply the foundations of mathematical principles such as algebra, geometry, and advanced math to solve problems.

3.6 Apply basic scientific principles and methods to solve problems and complete tasks.

3.7 Understand computer operations and related applications to input, store, retrieve, and output information as it relates to the course.

3.8 Research, recognize, and understand the interactions of the environment and *green* issues as they relate to the course work and to a global economy.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

3.1A Uses appropriate time management to achieve goals.

3.1B Arrives at school on time each day.

3.1C Completes assignments and meets deadlines.

3.2A Assesses current personal study skills.

3.2B Demonstrates advanced note-taking ability.

3.2C Formulates appropriate study strategies for given tasks.

3.3A Communicates ideas, information, and messages in a logical manner.

3.3B Fills out forms, reports, logs, and documents to comply with class and project requirements.

3.4A Reads and understands technical documents and uses industry jargon, acronyms, and terminology appropriately.

3.4B Recognizes the meaning of specialized words or phrases unique to the career and industry.

3.5A Utilizes computation in adding, subtracting, multiplying, and dividing of whole numbers, fractions, decimals, and percents.

3.5B Chooses the right mathematical method or formula to solve a problem.

3.5C Performs math operations accurately to complete classroom and lab tasks.

3.6A Understands scientific principles critical to the course.

3.6B Applies scientific principles and technology to solve problems and complete tasks.

3.6C Has knowledge of the scientific method (e.g., identifies the problem, collects information, forms opinions, and draws conclusions).
3.7A Uses basic computer hardware (e.g., PCs, printers) and software to perform tasks as required for the course work.
3.7B Understands capabilities of computers and common computer terminology (e.g., program, operating system).
3.7C Applies the appropriate technical solution to complete tasks.
3.7D Inputs data and information accurately for the course requirements.
3.8A Researches and recognizes *green* trends in career area and industry.
3.8B Examines current environmentally friendly trends.
3.8C Applies sustainability practices by understanding processes that are non-polluting, conserving of energy and natural resources, and economically efficient.

SAMPLE PERFORMANCE TASKS

- Examine and compile different learning styles for portfolios.
- Create calendars containing all activities and obligations for one month. Discusses how to handle conflicting or competing obligations then complete daily and weekly plans showing tasks, priorities, and scheduling.
- Complete self-assessments of study habits.
- Compute precise and exact measurements.
- Explore study strategies for different subjects and tasks then analyze two homework assignments and select the best strategies for completing them.
- Create "life maps" showing necessary steps or "landmarks" along the path to personal, financial, educational, and career goals.
- Take notes during counselor classroom visits and work in small groups to create flow charts of the path options.
- List attitudes that lead to success then rate individually in these areas. Work together to suggest strategies for overcoming the weaknesses identified own and partners' self-assessments then share with the class the strategies developed.
- Research the Internet and other technology to collect and analyze data concerning climate change.
- Keep a data file of alternative energy sources and the sources' impact on the environment.
- Develop a recycling project at home or for the school environment.

INTEGRATION LINKAGES

SkillsUSA, *Professional Development Program*; SkillsUSA; Communications and Writing Skills; Teambuilding Skills; Research; Language Arts; Sociology; Psychology; Math; Technical Math; English IV: Communication for Life; Social Studies; Problem Solving; Interpersonal Skills; Employability Skills; Critical-Thinking Skills; Secretary's Commission on Achieving Necessary Skills (SCANS); Chamber of Commerce; Colleges; Universities; Technology Centers; Secretary's Commission on Achieving Necessary Skills (SCANS)

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STANDARD 4.0

Students will demonstrate the use of gates and counters in logic circuits.

LEARNING EXPECTATIONS

The student will:
4.1   Construct logic circuits using gates.
4.2   Construct logic circuits using flip-flops, counters, and gates.

PERFORMANCE INDICATORS: EVIDENCE STANDARD IS MET

The student:
4.1A   Analyzes the function of gates in logic circuits.
4.1B   Constructs logic circuits using AND, OR, NOR, and XOR gates as described by logic statements and schematic circuits
4.2A   Analyzes the function of flip-flops, counters, and gates in logic circuits.
4.2B   Constructs logic circuits using flip-flops, counters, and gates as described by given logic statements and schematic circuits.

SAMPLE PERFORMANCE TASKS

- Create a circuits wing AND, OR, NOR, and XOR gates to execute given Boolean expressions based on several inputs.
- Create circuits using flip-flops to act as a counter.
- Create a circuit using flip-flops to make a four digit binary to decimal converter.

INTEGRATION/LINKAGES

International Technology Education Association. *Standards for Technological Literacy: Content for the Study of Technology.* International Technology Education Association. Reston, VA, 2000. Mathematics concepts and skills. Computer Science concepts and skills.

DIGITAL ELECTRONICS

STANDARD 5.0

Students will demonstrate the use of oscillators in logic circuits.

LEARNING EXPECTATIONS

The student will:
5.1   Examine the functions of RC (resistor and capacitor) and crystal-controlled oscillators.
5.2   Construct RC and crystal-controlled oscillators.

PERFORMANCE INDICATORS: EVIDENCE STANDARD IS MET

The student:
5.1A   Analyzes the purpose and functions of RC and crystal-controlled oscillators.
5.1B   Generates examples of uses of oscillators.
5.2A   Interprets schematics containing oscillator circuits.
5.2B   Constructs RC and crystal-controlled oscillators based on schematics.

SAMPLE PERFORMANCE TASKS

- Build an oscillator circuit (RC) to provide a clock signal.
- Build an oscillator circuit (crystal-controlled) to provide a precision clock signal.
- Build a multitone oscillator system (organ).
- Build a tone generator for signal tracing.

INTEGRATION/LINKAGES

International Technology Education Association. *Standards for Technological Literacy: Content for the Study of Technology.* International Technology Education Association. Reston, VA, 2000. Mathematics concepts and skills. Computer Science concepts and skills.

DIGITAL ELECTRONICS

STANDARD 6.0

Students will demonstrate the functions of switches and multiplexers in signal distribution and operate them.

LEARNING EXPECTATIONS

The student will:
6.1   Use digitally controlled analog switches to control analog and digital signal distribution.
6.2   Use analog switches to perform multiplexing functions.

PERFORMANCE INDICATORS: EVIDENCE STANDARD IS MET

The student:
6.1A   Explains and demonstrates the features and functions of digitally controlled analog switches.
6.1B   Applies digitally controlled analog switches to control analog and digital signal distribution as described by schematic circuits.
6.2A   Identifies desired multiplexing functions.
6.2B   Groups analog switches to perform the desired multiplexing functions.

SAMPLE PERFORMANCE TASKS

- Create a circuit that serves as a synchronous detector.
- Construct an eight-channel analog multiplexer using discrete components.
- Build a circuit to turn on a rectangular array of LEDs (light-emitting diodes) to display alphanumeric characters.

INTEGRATION/LINKAGES

International Technology Education Association. *Standards for Technological Literacy: Content for the Study of Technology.* International Technology Education Association. Reston, VA, 2000. Mathematics concepts and skills. Computer Science concepts and skills.

DIGITAL ELECTRONICS

STANDARD 7.0

Students will demonstrate the functions of analog and digital convertors and operate them.

LEARNING EXPECTATIONS

The student will:
7.1 Compare and contrast analog and digital data.
7.2 Determine sampling rates required for input signals.
7.3 Interpret and create block diagrams of D/A (digital/analog) and A/D convertors.

PERFORMANCE INDICATORS: EVIDENCE STANDARD IS MET

The student:
7.1A Distinguishes the characteristics of analog versus digital data.
7.1B Explains the consequences of choices at level of quantization (sample rate, number of bits, etc.).
7.2A Evaluates sampling rates.
7.2B Determines the minimum sampling rate required for an input signal of known maximum frequency.
7.3A Draws block diagrams of successive approximation D/A convertors.
7.3B Draws block diagrams of successive approximation A/D convertors.

SAMPLE PERFORMANCE TASKS

- Display on an oscilloscope simultaneously the analog input and serial digital output of a A/D converter.
- Observe efforts of sampling rate at an A/D-D/A pair on the analog signal in and out.
- Determine suitability of a converter based on block diagrams and specifications for an application such as audio conversion.

INTEGRATION/LINKAGES

International Technology Education Association. *Standards for Technological Literacy: Content for the Study of Technology.* International Technology Education Association. Reston, VA, 2000. Mathematics concepts and skills. Computer Science concepts and skills.

DIGITAL ELECTRONICS

STANDARD 8.0

Students will program and modify microcontrollers.

LEARNING EXPECTATIONS

The student will:
8.1   Use and modify microcontroller features.
8.2   Explore microcontroller support devices.
8.3   Program microcontrollers.

PERFORMANCE INDICATORS: EVIDENCE STANDARD IS MET

The student:
8.1A   Describes and explains the basic features of microcontrollers.
8.1B   Uses a high-level computer language and compiler to debug and modify existing microcontroller programs to achieve desired results.
8.2A   Identifies typical peripheral chips and devices used to support microcontrollers, such as memory, display, and signal interface chips.
8.2B   Illustrates the functions of typical peripheral chips and devices used to support microcontrollers.
8.3A   Constructs and programs computational algorithms on breadboarded microcontrollers to read and display analog and digital input.
8.3B   Modifies input signals to create desired outputs (digital and/or analog).
8.3C   Creates servo controls for a given purpose.

SAMPLE PERFORMANCE TASKS

- Modify an existing numerically-controlled program to accomplish a minor change in result.
- Design and program a microcontroller temperature control circuit for an industrial oven to follow a specified temperature profile.

INTEGRATION/LINKAGES

International Technology Education Association. *Standards for Technological Literacy: Content for the Study of Technology.* International Technology Education Association. Reston, VA, 2000. Mathematics concepts and skills. Computer Science concepts and skills.

DIGITAL ELECTRONICS

<u>SAMPLING OF AVAILABLE RESOURCES</u>

- ➤ *Digital Electronics: Principles and Applications*. Glencoe, 1999.

- ➤ *Digital Electronics: A Simplified Approach*. Prentice-Hall, 2001.

- ➤ *Digital Systems: Principles and Applications*. Prentice-Hall, 2001.

- ➤ *Practical Approach to Digital Electronics*. Prentice-Hall, 2000.

- ➤ *First Course in Digital Electronics*. Prentice-Hall, 1999.

- ➤ *Introductory Digital Electronics*. Prentice-Hall, 1998.