Electronics Systems II

8412 36 weeks

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Course Description

Suggested Grade Level: 10 or 11 or 12
Prerequisites: 8416

Electronic devices are everywhere in modern life and business and, as a result, opportunities abound for any who should master the knowledge and skills to design, alter, repair, and construct them. This course allows students to advance their application of scientific theories and take a systems approach to working with semiconductor devices, digital components, and logic circuits.

They also study integrated circuits used in computers, amplifiers, media equipment, and other devices.

Task Essentials Table

- Tasks/competencies designated by plus icons (⊕) in the left-hand column(s) are essential
- Tasks/competencies designated by empty-circle icons (○) are optional
- Tasks/competencies designated by minus icons (⊖) are omitted
- Tasks marked with an asterisk (*) are sensitive.

Task Number	8412	Tasks/Competencies
Introducing the Electronics Industry		
39	⊕	Demonstrate the use of electronic lab equipment.
40	⊕	Research occupational opportunities.
Exploring Semiconductor Devices		
41	⊕	Describe the characteristics, operation, and applications of basic semiconductor devices.
42	⊕	Identify semiconductor materials and the rationale behind their use.
43	⊕	Identify types of semiconductor memories.
43	⊕	Compare Direct Current (DC) and Actual Current (AC) waveforms, using an oscilloscope.
44	⊕	Describe the basic characteristics of amplifiers.
45	⊕	Construct an amplifier circuit.
46	⊕	Describe the characteristics, operation, and applications of power-supply circuits.
47	⊕	Identify schematic symbols for circuit components.
48	⊕	Describe inductance.
49	⊕	Construct a power-supply circuit.
50	⊕	Describe modulation methods.

51	⊕	Describe integrated circuit (IC) chip transistor type and terminals.	
52	⊕	Classify integrated circuits.	
53	⊕	Test the amplifier circuits.	
54	⊕	Design circuits containing integrated circuit components.	
Exploring Diodes			
55	⊕	Describe the operation of basic semiconductor devices.	
56	⊕	Identify the main function of a diode.	
57	⊕	Identify diode materials and components.	
58	⊕	Describe the types of diodes and their applications.	
59	⊕	Connect a PN junction.	
60	⊕	Forward-bias a diode.	
61	⊕	Reverse-bias a diode.	
62	⊕	Compare the functions and characteristics of diodes.	
Implementing Digital Microprocessors and Microcontrollers			
63	⊕	Compare analog and digital devices.	
64	⊕	Describe the function of major components used in implementing digital circuits.	
65	⊕	Describe the input and output interfaces of microprocessors and microcontrollers.	
66	⊕	Design a device to be controlled by a microcontroller.	
67	⊕	Manipulate the microcontroller device, using object-oriented programming.	
Investigating Digital Electronics and Logic Circuits			
68	⊕	Convert between the binary and decimal number systems.	
69	⊕	Describe Boolean logic and its role in logic circuits.	
70	⊕	Describe the operation of basic logic circuits.	

71	⊕	Describe logic gates and their functions.	
72	⊕	Describe the characteristics of sequential and combinational logic circuits.	
73	⊕	Compare combinational and sequential logic.	
74	⊕	Describe the function of AND, OR, and inverter gates.	
75	⊕	Design a basic logic circuit.	
76	⊕	Simulate a simple, combinational logic circuit designed with AND, OR, and inverter gates.	
77	⊕	Construct a functional, combinational logic circuit, using logic gates.	
78	⊕	Describe the function of a D flip-flop.	
79	⊕	Simulate a simple, sequential logic circuit design with D flip-flops.	
80	⊕	Construct logic circuits to meet design-brief goals.	
81	⊕	Analyze values in AC circuits.	
82	⊕	Construct AC circuits from schematics.	
83	⊕	Describe the operation and function of a transformer.	
Exploring Transistors			
84	⊕	Describe the types of transistors and their functions.	
85	⊕	Describe transistor materials, components, and construction techniques.	
86	⊕	Describe transistor configurations.	
87	⊕	Reconfigure a transistor.	
88	⊕	Describe transistor circuit characteristics.	
89	⊕	Compare transistor ratings.	
90	⊕	Test a transistor.	
Working with Amplifiers			
01	⊕	Describe the types and functions of amplifiers.	

92	⊕	Describe the characteristics of amplifier circuits.	
93	⊕	Reconfigure an amplifier's biasing.	
94	⊕	Apply an amplifier coupling.	
95	⊕	Describe capacitance.	

Legend: ⊕Essential ○Non-essential ⊖Omitted

Curriculum Framework

Introducing the Electronics Industry

Task Number 39

Demonstrate the use of electronic lab equipment.

Definition

Demonstration should include

- training and performance with all tools, machines, equipment, and supplies (including care and maintenance of all items)
- monitored/supervised performance during each activity
- ability to locate posted safety rules, precautions, first aid and emergency instructions, and Safety Data Sheets (SDS)
- awareness of Electrostatic Discharge
- willingness to wear personal protective equipment (PPE), when necessary, and to adhere to injury-reporting protocols.

Process/Skill Questions

- Why is safety important in the lab and in the workplace?
- What safety precautions should be taken when using hand tools, machines, equipment, and chemicals in a lab?
- What safety precautions and responsibilities should be considered for various areas where electronics are used or different fields of electronics?

ITEEA National Standards

12. Use and Maintain Technological Products and Systems

16. Energy and Power Technologies

TSA Competitive Events

Animatronics

Principles of Technology (Virginia only)

Task Number 40

Research occupational opportunities.

Definition

Research should include

- using career cluster resources to identify career pathways and occupations related to electronics
- accessing job-search (e.g., Monster, CareerBuilder, Dice) and employment outlook sites (e.g., Virginia Employment Commission, U.S. Bureau of Labor Statistics, O*Net)
- narrowing the search to a sample of occupational titles (below) and comparing the elements of each, such as educational requirements, salary expectations, and professional demands
    - computer engineering
    - design
    - build
    - operation
    - repair
    - factory design
    - data center
    - homes
- identifying career opportunities at national, state, and local levels.

Process/Skill Questions

- What are the major career paths within the field of electronics? What are the qualifications for each?
- What typical tasks are performed in each path?

- What types of entry-level jobs are there for electronics professionals in the energy industry?
- How are different careers in electronics endorsed by professional organizations?

ITEEA National Standards

16. Energy and Power Technologies

19. Manufacturing Technologies

4. The Cultural, Social, Economic, and Political Effects of Technology

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Exploring Semiconductor Devices

Task Number 41

Describe the characteristics, operation, and applications of basic semiconductor devices.

Definition

Description should include

- characteristics of basic semiconductor devices
- operation of basic semiconductor devices (used to switch, amplify, and control direction of current flow)
- diode construction techniques
- transistor construction principles
- real-world applications of integrated circuits using diode and transistor elements.

Process/Skill Questions

- What are the electrical characteristics of semiconductor components?
- What are the advantages and disadvantages of semiconductor devices?
- How do the components operate, and what are their applications?

- How are differences in reverse current (IR), peak inverse voltage (PIV), maximum forward current (IF Max), and reverse voltage important when selecting a replacement diode?
- What is implied by different values of forward voltage drop (EF) in diodes?
- How are forward bias and reverse bias similar/different?
- What is the relationship between the depletion region, barrier voltage, and biasing voltage?
- What is the difference between peak-reverse voltage and peak-inverse voltage (PIV)?
- How are collector, emitter, and base similar/different to source, gate, and drain?
- What is the difference between depletion and enhancement mode metal-oxide-semiconductor field-effect transistor (MOSFETs)?

ITEEA National Standards

1. The Characteristics and Scope of Technology

11. Apply the Design Processes

12. Use and Maintain Technological Products and Systems

13. Assess the Impact of Products and Systems

16. Energy and Power Technologies

2. The Core Concepts of Technology

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

4. The Cultural, Social, Economic, and Political Effects of Technology

5. The Effects of Technology on the Environment

6. The Role of Society in the Development and Use of Technology

7. The Influence of Technology on History

TSA Competitive Events

Animatronics

System Control Technology

Task Number 42

Identify semiconductor materials and the rationale behind their use.

Definition

Identification should include

- germanium and silicon atoms, crystals, and their conductive qualities
    - low/high temperature characteristics
    - holes and current flow
- conduction in doped germanium and silicon
    - N-type material
    - P-type materials.

Process/Skill Questions

- Why are semiconductors considered active components?
- What makes germanium and silicon good elements for semiconductors?
- How are N-type and P-type materials produced?

ITEEA National Standards

16. Energy and Power Technologies

Task Number 43

Identify types of semiconductor memories.

Definition

Identification should include

- researching the types of memory used in digital circuitry
- comparing memory types
- researching current trends in emerging technologies related to digital data.

Process/Skill Questions

- What is *digital memory*, and how is it stored?

- How do these circuits operate?
- How are these circuits used to store information?
- How are memory circuits used to convert data?

ITEEA National Standards

16. Energy and Power Technologies

Task Number 44

Compare Direct Current (DC) and Actual Current (AC) waveforms, using an oscilloscope.

Definition

Comparison should include

- identifying the types of meters available for AC measurements
- demonstrating the use and operation of an oscilloscope
- identifying the basic parts of an oscilloscope
- identifying the types of waveforms
- examining wavelengths, amplitude, range, and variance of DC and AC waveforms
- identifying DC and AC applications.

Process/Skill Questions

- What is the difference between a sinusoidal and non-sinusoidal waveform?
- What are the three types of non-sinusoidal waveforms?
- What is the difference between peak value and peak-to-peak value in a waveform?
- How is an AC wave different from a DC wave?
- How does this difference affect application?

ITEEA National Standards

16. Energy and Power Technologies

Task Number 45

Describe the basic characteristics of amplifiers.

Definition

Description should include the

- function of amplifiers
- components of basic amplifiers
- classes of amplifiers
- examples of amplifiers (e.g., audio, radio frequency, operational, and signal).

Process/Skill Questions

- Which components are used as amplifiers?
- What are the characteristics of amplifiers?
- How are amplifiers classified?

ITEEA National Standards

1. The Characteristics and Scope of Technology

10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

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TSA Competitive Events

System Control Technology

Task Number 46

Construct an amplifier circuit.

Definition

Construction should include

- analyzing the amplifier circuits, using test instruments
- verifying the characteristics
- building an audio amplifier
- testing the audio amplifier's performance with a variety of signals.

Process/Skill Questions

- How are circuit characteristics verified?
- What are the applications for amplifiers?
- What are the design constraints for amplifiers?

ITEEA National Standards

1. The Characteristics and Scope of Technology

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7. The Influence of Technology on History

8. The Attributes of Design

9. Engineering Design

TSA Competitive Events

System Control Technology

Task Number 47

Describe the characteristics, operation, and applications of power-supply circuits.

Definition

Description should include the

- characteristics of power-supply circuits—basic stages and associated components
- basic purpose or function of a power-supply circuit
- operation of power-supply circuits—graphing the voltage pattern at each stage of a power supply's operation
- types of voltage regulators and how they operate
- applications of power-supply circuits (e.g., DC power supplies, AC power supplies, switching power supplies associated with computers and digital electronics).

Process/Skill Questions

- Which components are used as power supplies?
- What are the characteristics of power supplies?
- How are power supplies classified?
- What are the different types of rectifiers?
- What are the comparative features of fuses, slow-blow fuses, and circuit breakers?
- How does a rectifier circuit work?
- What is the difference between a transformer and an inductor?
- What is the difference between a voltage regulator and a shunt regulator?
- What are the strengths and weaknesses of a series regulator?
- What are common examples of products containing over-voltage protection circuits?
- What are the implications of ripple frequency?

ITEEA National Standards

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16. Energy and Power Technologies

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TSA Competitive Events

System Control Technology

Task Number 48

Identify schematic symbols for circuit components.

Definition

Identification should include

- demonstrating the graphical symbols of electrical and electronics
- matching symbols to components, including
    - resistors
    - battery and ground
    - bulbs, LED
    - diodes
    - transistors
    - switches
    - motors
    - IC chips
    - symbol features vs. component features.

Process/Skill Questions

- What is a schematic diagram?
- How are some schematic diagrams used in the electronics industry?
- How are schematic diagrams used to construct and analyze circuits?

ITEEA National Standards

16. Energy and Power Technologies

Task Number 49

Describe inductance.

Definition

Description should include

- explaining the principles of inductance
- identifying the basic units of inductance
- identifying the different types of inductors
- explaining inductor-resistor (L/R) time constants and how they relate to inductance calculating total inductance in series and parallel circuits.
- explaining L/R time constants and how they relate to inductance
- calculating total inductance in series and parallel circuits.

Process/Skill Questions

- What is an inductor?
- What are the characteristics of an inductor?
- How is electricity transported through the air?

ITEEA National Standards

16. Energy and Power Technologies

Task Number 50

Construct a power-supply circuit.

Definition

Construction should include

- analyzing the power-supply circuit, using test instruments
- verifying the characteristics
- inspecting the power-supply signal at each stage of operation
- verifying the function and device operation.

Process/Skill Questions

- How are circuit characteristics verified?

- What are the applications for power supplies?
- What are the design constraints for power supplies?

ITEEA National Standards

1. The Characteristics and Scope of Technology

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8. The Attributes of Design

9. Engineering Design

TSA Competitive Events

Animatronics

System Control Technology

Task Number 51

Describe modulation methods.

Definition

Description should include the

- characteristics of modulation—the combination of a carrier signal of periodic waveform (i.e., baseband) with a data information signal (i.e., passband) to be transmitted
- various methods of achieving modulation—frequency modulation (FM), amplitude modulation (AM), phase modulation, phase-shift keying, digital modulation method (i.e., modems), and pulse modulation methods (pulse width modulation [PWM]).

Process/Skill Questions

- What are the types of modulation, and how do they differ?
- What electronic circuitry is necessary to transmit and receive modulation?
- What are the applications of modulation circuits?

ITEEA National Standards

1. The Characteristics and Scope of Technology

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9. Engineering Design

TSA Competitive Events

System Control Technology

Task Number 52

Describe integrated circuit (IC) chip transistor type and terminals.

Definition

Description should include

- identifying types of bipolar terminals (e.g., base, collector, and emitter)
- identifying types of terminals (e.g., field-effect, gate, source, and drain)
- describing transistor-transistor logic (TTL) and complementary metal oxide-semiconductor (CMOS) IC families
- reading a pin diagram
- correlating the markings on the chip (e.g., manufacturer code, family, subfamily, function of IC, packaging code)
- identifying types of IC packaging (e.g., round, square, rectangular)
- identifying IC schematic symbol.

Process/Skill Questions

- What is a pin diagram?
- Where might you find the subfamily to which the chip belongs?
- Why are there different types of IC packaging?

ITEEA National Standards

16. Energy and Power Technologies

Task Number 53

Classify integrated circuits.

Definition

Classification should include assigning integrated circuits to the following classes and describing classification characteristics:

- Analog integrated circuits
- Digital integrated circuits--TTL, emitter-coupled logic (ECL), CMOS
- Small-scale integration (SSI), large-scale integration (LSI), giga-scale integration (GSI)

Process/Skill Questions

- What are the construction methods for manufacturing integrated circuits?
- What are the scales of integration?
- What are the advantages and disadvantages of integrated circuits?
- How are integrated circuits identified and packaged?

ITEEA National Standards

1. The Characteristics and Scope of Technology

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17. Information and Communication Technologies

18. Transportation Technologies

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7. The Influence of Technology on History

8. The Attributes of Design

9. Engineering Design

TSA Competitive Events

System Control Technology

Task Number 54

Test the amplifier circuits.

Definition

Testing should include an analysis of the characteristics, operation, and applications of IC, using

- mathematics
- instrumentation circuits (e.g., construct and test, IC tester or breadboarding with logic probe, oscilloscope, multi-meter)
- computer simulation.

Process/Skill Questions

- How do theoretical, actual, and simulated circuit characteristics differ?
- How can mathematics be used to predict circuit characteristics?
- How can circuit theory be verified, using various test instruments and computer-assisted simulation?
- How can test instruments facilitate electronic equipment troubleshooting?

ITEEA National Standards

16. Energy and Power Technologies

Task Number 55

Design circuits containing integrated circuit components.

Definition

Design should include a

- problem statement specifying the desired circuit function

- schematic design and simulation
- verification of operation - breadboarding the circuit, testing, verifying, and describing demonstrated operation.

Process/Skill Questions

- What operational characteristics should the circuit have?
- How can a schematic or a computer-based simulation represent a circuit's operation?
- How can a circuit be temporarily constructed for real-world validation of design work?

ITEEA National Standards

10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

11. Apply the Design Processes

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9. Engineering Design

TSA Competitive Events

Animatronics

Engineering Design

Principles of Technology (Virginia only)

System Control Technology

Technology Problem Solving

Exploring Diodes

Task Number 56

Describe the operation of basic semiconductor devices.

Definition

Description should include

- explaining the purpose of semiconductor devices (e.g., diode, transistors)
- comparing types of transistors (e.g., positive-negative-positive ([PNP]/ negative-positive-negative [NPN], bipolar junction/field-effect).

Process/Skill Questions

- What are the electrical characteristics of semiconductor components?
- What are the advantages and disadvantages of semiconductor devices?
- How do the components operate, and what are their basic applications?

ITEEA National Standards

16. Energy and Power Technologies

Task Number 57

Identify the main function of a diode.

Definition

Identification should include

- describing the role of asymmetric conductance
- explaining how anodes and cathodes function
- describing the process of forward bias.

Process/Skill Questions

- What allows a generic diode to resist current flow in a certain direction?
- How can diodes be used to control alternating current?
- What is *forward bias*?

ITEEA National Standards

16. Energy and Power Technologies

Task Number 58

Identify diode materials and components.

Definition

Identification should include

- germanium diodes
- silicon diodes.

Process/Skill Questions

- How are arrows and lines used to differentiate diode symbols?
- How does the material of a diode affect its electrical characteristics?
- What are the components of a diode?

ITEEA National Standards

16. Energy and Power Technologies

Task Number 59

Describe the types of diodes and their applications.

Definition

Description should include

- types of diodes (e.g., grown and alloyed; diffused and packaging)
- applications of diodes (e.g., rectification, regulation).

Process/Skill Questions

- What role do diodes play in AC-DC circuits?

- What diode configurations are used to convert alternating current to direct current?
- What diode configurations regulate voltage?

ITEEA National Standards

16. Energy and Power Technologies

Task Number 60

Connect a PN junction.

Definition

Connection should include

- description of the reaction of ions
- use of a junction diode
- increase of depletion layer
- electron drift
- hole diffusion
- electron diffusion
- steady state.

Process/Skill Questions

- What pairs of periodic elements are used to create PN junctions?
- What is a PN junction's purpose?
- What is hole diffusion?

ITEEA National Standards

16. Energy and Power Technologies

Task Number 61

Forward-bias a diode.

Definition

Forward-biasing should include

- hydraulic check valve analogy
- current flow prohibited
- current flow permitted
- polarity.

Process/Skill Questions

- What are ways to visually check the polarity of a diode?
- What are ways to represent electrical components as equivalent water circuits?
- Why should one forward-bias a diode?

ITEEA National Standards

16. Energy and Power Technologies

Task Number 62

Reverse-bias a diode.

Definition

Reverse-biasing should include

- depletion layer
- peak inverse voltage
- breakdown
- Zener diode.

Process/Skill Questions

- What characteristics must a diode have to be reverse-biased?
- Can a reverse-biased diode be used as a forward-biased diode? Why or why not?
- What does breakdown refer to, as it relates to the reverse bias of a diode?

ITEEA National Standards

16. Energy and Power Technologies

Task Number 63

Compare the functions and characteristics of diodes.

Definition

Comparison should include

- identifying diode ratings
- correlating symbols and temperature characteristics
- describing diode construction
- describing applications
- describing specialty diodes.

Process/Skill Questions

- How is the rating of a diode determined?
- What are some uses of different type of diodes?
- What are examples of specialty diodes?

ITEEA National Standards

16. Energy and Power Technologies

Implementing Digital Microprocessors and Microcontrollers

Task Number 64

Compare analog and digital devices.

Definition

Comparison should include

- similarities
    - electromotive force
    - current

    - resistance
- differences
    - clock-pulse
    - intelligent decisions/power.

Process/Skill Questions

- In what ways is a radio similar to a drill press? How do they differ from each other?
- Why is a digital receiver more accurate than an analog receiver?

ITEEA National Standards

16. Energy and Power Technologies

6. The Role of Society in the Development and Use of Technology

TSA Competitive Events

System Control Technology

Task Number 65

Describe the function of major components used in implementing digital circuits.

Definition

Description should include

- the microcontroller clock pulse
- sensors and registers (e.g., random access memory [RAM], read-only memory [ROM])
- memory storage devices – volatile and nonvolatile (e.g., RAM, ROM)
- memories and registers (e.g., RAM, ROM, volatile and non-volatile memory)
- switches and input/output (I/O) ports.

Process/Skill Questions

- How does a microcontroller work?
- What is the function of a clock pulse?
- How is clock speed measured?

ITEEA National Standards

16. Energy and Power Technologies

19. Manufacturing Technologies

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

TSA Competitive Events

Computer Integrated Manufacturing (CIM)

System Control Technology

Task Number 66

Describe the input and output interfaces of microprocessors and microcontrollers.

Definition

Description should include

- internal microprocessor components (e.g., registers, arithmetic logic unit [ALU], central processing unit [CPU], co-processors, processor bus, primary cache memory, clock)
- external microprocessor components (e.g., secondary cache, main memory, external I/O bus, network interface, input devices, output devices, external memory devices, secondary storage, motherboard)
- system on a chip (SOC) – full computer on a chip.

Process/Skill Questions

- How do the internal and external parts of a computer work?
- How do microcomputers operate?
- What is meant by *computer numeric control*?
- What are the pros and cons of computer numeric control?
- What circuits/elements make up a microprocessor?
- What is the difference between a microprocessor and a microcomputer?

ITEEA National Standards

16. Energy and Power Technologies

Task Number 67

Design a device to be controlled by a microcontroller.

Definition

Design should include

- establishing the way the device will meet a need or solve a problem
- designing and drawing a functional device
- assembling the digital electronic components on a frame.

Process/Skill Questions

- What is meant by *user interface*?
- How does the designed device use machine language?
- Why is a precise logical language used when programming devices?
- What is an autonomous device? What are some examples?

ITEEA National Standards

10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

11. Apply the Design Processes

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19. Manufacturing Technologies

8. The Attributes of Design

9. Engineering Design

TSA Competitive Events

Animatronics

Computer Integrated Manufacturing (CIM)

Engineering Design

System Control Technology

Task Number 68

Manipulate the microcontroller device, using object-oriented programming.

Definition

Manipulation should include

- writing code to program a microcontroller to use sensors
- using mathematical operations, logical operators, input/output ports, breadboards, and electronic components.

Process/Skill Questions

- How is object-oriented programming different from ordinary programming?
- What are the logical and relational operators of programming language?

ITEEA National Standards

11. Apply the Design Processes

16. Energy and Power Technologies

19. Manufacturing Technologies

8. The Attributes of Design

9. Engineering Design

TSA Competitive Events

Animatronics

Computer Integrated Manufacturing (CIM)

Engineering Design

Investigating Digital Electronics and Logic Circuits

Task Number 69

Convert between the binary and decimal number systems.

Definition

Conversions should include

- identifying the most commonly used binary codes
- describing the functions of number systems (e.g., binary, decimal, octal, hexadecimal, 8421 binary code decimal [BCD])
- assigning value to bytes and bits through binary numbers.

Process/Skill Questions

- What is a number system? What is its relationship to logic circuitry?
- What are the common codes used in advanced electronics, and where are they referenced?
- What are the advantages and disadvantages of parallel and serial data?
- How are conversions made from one code system to another?
- How do different code systems affect the transmission of data?

ITEEA National Standards

16. Energy and Power Technologies

19. Manufacturing Technologies

2. The Core Concepts of Technology

TSA Competitive Events

Principles of Technology (Virginia only)

Task Number 70

Describe Boolean logic and its role in logic circuits.

Definition

Description should include

- identifying the mathematical and graphical methods that simplify and reduce logic circuits
- explaining the function of a Veitch diagram
- describing how to use a Veitch diagram to simplify Boolean expressions
- explaining the function of a Karnaugh map
- describing how to simplify Boolean expressions, using a Karnaugh map.

Process/Skill Questions

- What is the primary function of establishing mathematical Boolean rules for logic circuits?
- What is the hierarchy of operations to apply mathematical Boolean rules for logic circuits?
- How and when is De Morgan's theorem used?
- How are logic equivalent circuits developed?
- What is a Karnaugh map, and how is it used to reduce circuitry?

ITEEA National Standards

16. Energy and Power Technologies

19. Manufacturing Technologies

2. The Core Concepts of Technology

TSA Competitive Events

Principles of Technology (Virginia only)

System Control Technology

Task Number 71

Describe the operation of basic logic circuits.

Definition

Description should include the operational similarities and differences of the 7400 and 4000 families of logic gates. It should also include

- bipolar junction transistors (BJT) vs. field effect transistors (FET)
- voltage requirements
- prefix (usually 74 or 40)
- metal-oxide-semiconductor (MOS) chips compared to TTL chips.

Process/Skill Questions

- What is the prefix for a TTL family chip?
- What is the prefix for aMOS family chip?
- Which family is more prone to damage by static electricity?
- Which chip functions better in higher voltage?
- Which chip functions better in lower voltage (5V or less)?

ITEEA National Standards

16. Energy and Power Technologies

19. Manufacturing Technologies

2. The Core Concepts of Technology

TSA Competitive Events

Animatronics

Principles of Technology (Virginia only)

System Control Technology

Task Number 72

Describe logic gates and their functions.

Definition

Description should include

- AND gate
- OR gate
- NOT gate
- NAND gate
- NOR gate
- EOR gate (XOR gate)
- ENOR gate (XNOR gate).

Process/Skill Questions

- What are the basic types of logic gates?
- What are the characteristics of basic logic gates, and how do they differ?
- How do logic gate differences allow for a variety of operations?

ITEEA National Standards

16. Energy and Power Technologies

19. Manufacturing Technologies

2. The Core Concepts of Technology

TSA Competitive Events

Principles of Technology (Virginia only)

System Control Technology

Task Number 73

Describe the characteristics of sequential and combinational logic circuits.

Definition

Description of sequential logic circuits should include

- types of flip-flops
- counters (e.g., asynchronous, synchronous, decade, up/down, ring, IC74191 binary up/down) and shift registers
- associated schematic symbols
- applications.

Description of combinational logic circuits should include

- functions of encoders, decoders, multiplexers, adders, and comparators
- associated schematic symbols
- applications
- truth tables associated with a variety of combinational logic circuits.

Process/Skill Questions

- What are the characteristics of typical sequential and combinational logical circuits?
- What are the characteristics of counters, registers, clocks, and decoder circuits?
- How do logic circuits operate individually and as parts of other systems?
- What is microprogramming?

ITEEA National Standards

16. Energy and Power Technologies

19. Manufacturing Technologies

2. The Core Concepts of Technology

TSA Competitive Events

Principles of Technology (Virginia only)

System Control Technology

Task Number 74

Compare combinational and sequential logic.

Definition

Comparison should include

- combinational logic—involves decision making, using combinations of binary logic gates (e.g., (X + Y) + Z' = A) in which output is always the same, depending on the input (0 or 1)
- sequential logic—involves timing and memory circuits, typically used for counters and shift registers, in which output varies.

Process/Skill Questions

- How might a combinational logic circuit be used?
- How might a sequential logic circuit be used?
- What is a flip-flop?
- What is the relationship between a combinational logic diagram and its set of input?

ITEEA National Standards

12. Use and Maintain Technological Products and Systems

16. Energy and Power Technologies

19. Manufacturing Technologies

2. The Core Concepts of Technology

TSA Competitive Events

Principles of Technology (Virginia only)

System Control Technology

Task Number 75

Describe the function of AND, OR, and inverter gates.

Definition

Description should include the functions of the following:

- AND gate, the all-or-nothing gate, with its

    - expression
    - truth table
    - logic gate diagram
- OR gate, the any-or-all gate, with its
    - expression
    - truth table
    - logic gate diagram
- Inverter gates—NOR, the universal gate; NAND, the negated-AND gate; and XOR, the any-but-not-all gate, with their
    - expressions
    - truth tables
    - logic gate diagrams

Process/Skill Questions

- What is an example of a circuit using an AND gate?
- What is an example of a circuit using an OR gate?
- What is an example of a circuit using a NOR gate?
- What is an example of a circuit using a NAND gate?
- What is an example of a circuit using a XOR gate?
- What is the purpose of a NOT gate?

ITEEA National Standards

16. Energy and Power Technologies

19. Manufacturing Technologies

2. The Core Concepts of Technology

TSA Competitive Events

Principles of Technology (Virginia only)

System Control Technology

Task Number 76

Design a basic logic circuit.

Definition

Design should include a(n)

- IC chip
- power supply
- load
- conductor.

Process/Skill Questions

- How does a basic logic circuit operate?
- What is the purpose of using logic gates in a circuit?
- Why is it better to use an IC chip when switches might be conducted manually?

ITEEA National Standards

10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

11. Apply the Design Processes

12. Use and Maintain Technological Products and Systems

16. Energy and Power Technologies

19. Manufacturing Technologies

2. The Core Concepts of Technology

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

8. The Attributes of Design

9. Engineering Design

TSA Competitive Events

Animatronics

Engineering Design

System Control Technology

Task Number 77

Simulate a simple, combinational logic circuit designed with AND, OR, and inverter gates.

Definition

Simulation should test the circuit and include

- two or more IC chips/logic gates
- a power supply, a load, and a conductor.

Process/Skill Questions

- What is the purpose of using combinational logic gates in a circuit?
- How are two or more logic gates affected in a circuit using switches?

ITEEA National Standards

10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

11. Apply the Design Processes

12. Use and Maintain Technological Products and Systems

16. Energy and Power Technologies

19. Manufacturing Technologies

2. The Core Concepts of Technology

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

8. The Attributes of Design

9. Engineering Design

TSA Competitive Events

Computer-Aided Design (CAD), Engineering

Engineering Design

System Control Technology

Task Number 78

Construct a functional, combinational logic circuit, using logic gates.

Definition

Construction should include

- using a logic diagram to correctly connect the IC
- using two or more IC chips/logic gates
- designating a power supply, a load, and a conductor.

Process/Skill Questions

- What are the characteristics of typical combinational logic circuits?
- What are the characteristics of counters, registers, clocks, and decoder circuits?
- How do logic gates operate individually and as parts of other systems?
- How can basic logic gates be used to form a combinational logic circuit?

ITEEA National Standards

10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

11. Apply the Design Processes

12. Use and Maintain Technological Products and Systems

19. Manufacturing Technologies

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

8. The Attributes of Design

9. Engineering Design

TSA Competitive Events

Engineering Design

System Control Technology

Task Number 79

Describe the function of a D flip-flop.

Definition

Description of the function of a D flip-flop (also known as the bistable multivibrator, the data flip-flop, or the delay flip-flop) should include how it operates as a circuit that

- has two stable states
- can be used to store state information.

Process/Skill Questions

- What is the function of a flip-flop in a circuit?
- Which elements should always be included when diagramming a flip-flop using logic gates?

ITEEA National Standards

12. Use and Maintain Technological Products and Systems

16. Energy and Power Technologies

19. Manufacturing Technologies

2. The Core Concepts of Technology

TSA Competitive Events

Principles of Technology (Virginia only)

System Control Technology

Task Number 80

Simulate a simple, sequential logic circuit design with D flip-flops.

Definition

Simulation should test the circuit and include

- using a logic diagram to correctly connect the IC
- using two or more IC chips/logic gates
- designating a power supply, a load, and a conductor.

Process/Skill Questions

- How is a flip-flop used in a circuit?
- When is it appropriate to use a flip-flop in a circuit?

ITEEA National Standards

10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

11. Apply the Design Processes

12. Use and Maintain Technological Products and Systems

16. Energy and Power Technologies

19. Manufacturing Technologies

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

8. The Attributes of Design

9. Engineering Design

TSA Competitive Events

Computer-Aided Design (CAD), Engineering

Engineering Design

Task Number 81

Construct logic circuits to meet design-brief goals.

Definition

Construction should include

- identifying the problem and ideal outcome
- brainstorming possible solutions
- using a breadboard to simulate, test, and troubleshoot the solution
- creating a logic diagram to correctly connect the IC
- designing two or more IC chips/logic gates
- designating a power supply, a load, and a conductor.

Process/Skill Questions

- What is the path of current flow inside the logic circuit?
- What troubleshooting steps might be needed during the design process?
- What are the steps of a typical design process when conceptualizing a solution?

ITEEA National Standards

10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

11. Apply the Design Processes

12. Use and Maintain Technological Products and Systems

13. Assess the Impact of Products and Systems

16. Energy and Power Technologies

19. Manufacturing Technologies

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

8. The Attributes of Design

9. Engineering Design

TSA Competitive Events

Animatronics

Engineering Design

System Control Technology

Technology Problem Solving

Task Number 82

Analyze values in AC circuits.

Definition

Analysis should include determining

- inductance
- capacitance
- reactance.

Process/Skill Questions

- What are the characteristics of inductors and inductance, and how are they measured and evaluated?
- What are the characteristics of capacitors and capacitive circuits, and how are they measured and evaluated?
- What are the scientific and mathematical concepts related to inductive and capacitive circuits?
- What are the characteristics of inductive reactance, capacitive reactance, and impedance, and how do these characteristics relate to one another?
- How do complex AC circuits operate, and how are the AC circuit characteristics calculated and measured?
- What are the applications for inductive reactance, capacitive reactance, and combinational reactance circuits?
- How do inductive reactive and capacitive reactive circuits compare?
- How can Ohm's law and Watt's law be applied to analysis or design of reactive circuits?
- How do resistance, reactance, and impedance compare?

- How can test equipment and computer simulation be used to verify calculated complex AC circuit characteristics?
- What are the applications for reactive circuits?
- What are the differences in reactive circuits when their components are placed in series, parallel, or series-parallel configurations?

ITEEA National Standards

16. Energy and Power Technologies

Task Number 83

Construct AC circuits from schematics.

Definition

Construction should include

- identifying electronic symbols
- identifying electronic components
- identifying the problem
- drawing a schematic
- constructing the circuits with components.

Process/Skill Questions

- How are parts in a schematic diagram identified?
- How does one use an oscilloscope?
- What are electronic components?
- How is AC used differently from DC current?

ITEEA National Standards

16. Energy and Power Technologies

Task Number 84

Describe the operation and function of a transformer.

Definition

Description should include the

- characteristics of transformers
- process of operation in transformers
- application of transformers, including current examples
- types of transformers
    - isolation
    - variac
    - flyback
    - high-voltage
    - audio
    - residential.

Process/Skill Questions

- What is a transformer?
- How are transformers made, and what are the various applications for their use?
- What are the related scientific and mathematical concepts for transformers?
- How are voltage, current, and power ratios calculated to determine transformer efficiency?
- What are the advantages and disadvantages of using transformers in electronic circuits?
- How do transformers function in DC and AC circuits?
- How do magnetic fields, mutual inductance, and electromagnetic theory relate to the operation of transformers?

ITEEA National Standards

16. Energy and Power Technologies

Exploring Transistors

Task Number 85

Describe the types of transistors and their functions.

Definition

Description should include

- field-effect transistors
- integrated circuit fundamentals
- optoelectronic devices.

Process/Skill Questions

- What are some types of transistors?
- How does one determine what type of transistor is needed in a circuit?
- What are the different transistor circuit configurations?

ITEEA National Standards

16. Energy and Power Technologies

Task Number 86

Describe transistor materials, components, and construction techniques.

Definition

Description should include PNP and NPN transistors.

Process/Skill Questions

- What are ways a manufacturer can layer the transistor material?
- Is it possible to use a transistor as a diode?
- What are the components of a transistor?

ITEEA National Standards

16. Energy and Power Technologies

Task Number 87

Describe transistor configurations.

Definition

Description should include

- base
- collector
- emitter
- ground
- feedback.

Process/Skill Questions

- Why are transistors configured?
- What does the word *common* signify when describing transistor configurations?
- What are the characteristics of current and voltage in transistor configurations?

ITEEA National Standards

16. Energy and Power Technologies

Task Number 88

Reconfigure a transistor.

Definition

Reconfiguration should include

- PNP switch
- NPN switch
- cutoff
- saturation.

Process/Skill Questions

- How does one decide between using an NPN or PNP transistor?
- What circuit adjustments need to be made to switch between NPN and PNP transistors?
- Why should one reconfigure a transistor?

ITEEA National Standards

16. Energy and Power Technologies

Task Number 89

Describe transistor circuit characteristics.

Definition

Description should include

- common base
- common collector
- common emitter
- transistor action.

Process/Skill Questions

- What are some characteristics of transistor circuits?
- What does *common base* refer to?
- What does *common collector* refer to?

ITEEA National Standards

16. Energy and Power Technologies

Task Number 90

Compare transistor ratings.

Definition

Comparison should include

- alpha-beta
- cutoff-saturation
- input and output resistance.

Process/Skill Questions

- How do transistor values change as heat increases?
- What institutions set the standards for transistors?
- How does a saturated transistor function?

ITEEA National Standards

16. Energy and Power Technologies

Task Number 91

Test a transistor.

Definition

Test should include

- gain
- leakage
- shorts.

Process/Skill Questions

- What are common ways to break a transistor?
- What are ways to troubleshoot a transistor?
- What is a common cause of transistor failure?

ITEEA National Standards

16. Energy and Power Technologies

Working with Amplifiers

Task Number 92

Describe the types and functions of amplifiers.

Definition

Description should include

- direct current amplifiers
- audio amplifiers
- video amplifiers
- tuned amplifiers
- operational amplifiers
- differential amplifiers
- typical circuits
- integrated circuit (IC)/operational amplifiers (OP) families
- closed-loop operation
- inverting/non-inverting
- bandwidth limitations
- operational amplifier application and circuits
- adder
- active filter
- difference.

Process/Skill Questions

- How can a large amount of power be controlled by a small amount of power?
- What does the tuning mechanism control in an amplifier?
- What are some types of amplifiers?

ITEEA National Standards

16. Energy and Power Technologies

Task Number 93

Describe the characteristics of amplifier circuits.

Definition

Description should include

- common emitter
- common collector
- common base
- operational amplifiers.

Process/Skill Questions

- Why are common-emitter circuits used to amplify small signals and direct current?

- What makes common-base and common-collector circuits better for large signal manipulation?
- What is amplifier gain?

ITEEA National Standards

16. Energy and Power Technologies

Task Number 94

Reconfigure an amplifier's biasing.

Definition

Reconfiguration should include

- altering the circuit from base-biased to feedback-biased
- describing voltage dividers and classes of operation.

Process/Skill Questions

- What are the classes of amplifiers?
- What values are manipulated when biasing an amplifier?
- What are common ways a signal can change when going through an amplifier?

ITEEA National Standards

16. Energy and Power Technologies

Task Number 95

Apply an amplifier coupling.

Definition

Application should include

- calculating resistance and capacitance
- ensuring that transformer and impedance are matched.

Process/Skill Questions

- What can act as a coupler for amplifiers?
- What role does amplifier coupling play when creating an operational amplifier?
- What characteristics are shown when drawing amplifier schematics?

ITEEA National Standards

16. Energy and Power Technologies

Task Number 96

Describe capacitance.

Definition

Description should include the

- principles of capacitance
- ability of a body to store a charge
- farad, capacitive reactance, capacitor, impedance.

Process/Skill Questions

- How do parallel and series capacitors differ?
- How does a capacitor?
- What is a *farad*?

ITEEA National Standards

16. Energy and Power Technologies

SOL Correlation by Task

39	Demonstrate the use of electronic lab equipment.	History and Social Science: GOVT.14, GOVT.15 Science: CH.1

40	Research occupational opportunities.	English: 9.8, 10.8, 11.8, 12.8 Science: PH.4
41	Describe the characteristics, operation, and applications of basic semiconductor devices.	Science: PH.4, PH.10, PH.12
42	Identify semiconductor materials and the rationale behind their use.	
43	Identify types of semiconductor memories.	English: 9.8, 10.8, 11.8, 12.8
44	Compare Direct Current (DC) and Actual Current (AC) waveforms, using an oscilloscope.	English: 9.5, 10.5, 11.5, 12.5 Mathematics: T.3 Science: PH.8, PH.11
45	Describe the basic characteristics of amplifiers.	Science: PH.11
46	Construct an amplifier circuit.	Science: PH.11
47	Describe the characteristics, operation, and applications of power-supply circuits.	Science: PH.11
48	Identify schematic symbols for circuit components.	
49	Describe inductance.	English: 9.5, 10.5, 11.5, 12.5 Science: PH.11
50	Construct a power-supply circuit.	Science: PH.6, PH.11
51	Describe modulation methods.	English: 9.5, 10.5, 11.5, 12.5 Mathematics: T.3
52	Describe integrated circuit (IC) chip transistor type and terminals.	English: 9.5, 10.5, 11.5, 12.5
53	Classify integrated circuits.	
54	Test the amplifier circuits.	
55	Design circuits containing integrated circuit components.	Science: PH.1, PH.11
56	Describe the operation of basic semiconductor devices.	English: 9.5, 10.5, 11.5, 12.5
57	Identify the main function of a diode.	English: 9.5, 10.5, 11.5, 12.5
58	Identify diode materials and components.	
59	Describe the types of diodes and their applications.	
60	Connect a PN junction.	
61	Forward-bias a diode.	
62	Reverse-bias a diode.	
63	Compare the functions and characteristics of diodes.	English: 9.5, 10.5, 11.5, 12.5
64	Compare analog and digital devices.	Science: PH.11
65	Describe the function of major components used in implementing digital circuits.	English: 9.5, 10.5, 11.5, 12.5 Science: PH.11

66	Describe the input and output interfaces of microprocessors and microcontrollers.	Mathematics: COM.15, COM.16
67	Design a device to be controlled by a microcontroller.	Science: PH.1, PH.11
68	Manipulate the microcontroller device, using object-oriented programming.	Mathematics: A.1, AII.1, COM.1, COM.8, COM.11 Science: PH.1, PH.11
69	Convert between the binary and decimal number systems.	Mathematics: COM.15
70	Describe Boolean logic and its role in logic circuits.	English: 9.5, 10.5, 11.5, 12.5 Mathematics: COM.15, DM.9*
71	Describe the operation of basic logic circuits.	
72	Describe logic gates and their functions.	
73	Describe the characteristics of sequential and combinational logic circuits.	
74	Compare combinational and sequential logic.	
75	Describe the function of AND, OR, and inverter gates.	
76	Design a basic logic circuit.	Science: PH.1
77	Simulate a simple, combinational logic circuit designed with AND, OR, and inverter gates.	Mathematics: COM.8
78	Construct a functional, combinational logic circuit, using logic gates.	Mathematics: COM.8 Science: PH.11
79	Describe the function of a D flip-flop.	
80	Simulate a simple, sequential logic circuit design with D flip-flops.	
81	Construct logic circuits to meet design-brief goals.	Mathematics: COM.1 Science: PH.1
82	Analyze values in AC circuits.	English: 9.5, 10.5, 11.5, 12.5
83	Construct AC circuits from schematics.	
84	Describe the operation and function of a transformer.	English: 9.5, 10.5, 11.5, 12.5
85	Describe the types of transistors and their functions.	
86	Describe transistor materials, components, and construction techniques.	
87	Describe transistor configurations.	
88	Reconfigure a transistor.	
89	Describe transistor circuit characteristics.	
90	Compare transistor ratings.	English: 9.5, 10.5, 11.5, 12.5
91	Test a transistor.	
92	Describe the types and functions of amplifiers.	
93	Describe the characteristics of amplifier circuits.	
94	Reconfigure an amplifier’s biasing.	
95	Apply an amplifier coupling.	

96	Describe capacitance.	English: 9.5, 10.5, 11.5, 12.5

Boolean Laws

For more on Boolean laws, go to: https://www.electronics-tutorials.ws/boolean/bool_5.html

T1: Commutative Law

(a) A + B = B + A
(b) A B = B A

T2: Associate Law

(a) (A + B) + C = A + (B + C)
(b) (A B) C = A (B C)

T3: Distributive Law

(a) A (B + C) = A B + A C
(b) A + (B C) = (A + B) (A + C)

T4: Identity Law

(a) A + A = A
(b) A A = A

T5:

(a) AB + AB =A
(b) (A + B)A + B) = A

T6 : Redundance Law

o A + A B = A
(b) A (A + B) = A

T7:

(a) 0 + A = A
(b) 0 A = 0

T8:

(a) 1 + A = 1

(b) 1 A = A

T9:

(a) $A + \overline{A}\,B = A + B = 1$

(b) $A\,(\overline{A} + B) = AB$

T10:

(a) (b)

T11: De Morgan's Theorem
(a) (a) (1) Algebraically: (2) Using the truth table:

Cyber Security and Cyber Forensics Infusion Units

Cyber Security and Cyber Forensics Infusion Units (CYBR) were designed to be infused with designated CTE courses to help students in those programs achieve additional, focused, validated tasks/competencies in personal and professional cyber security skills. These units are not mandatory, and, as such, the tasks/competencies are marked as "optional," to be taught at the instructor's discretion.

Entrepreneurship Infusion Units

Entrepreneurship Infusion Units may be used to help students achieve additional, focused competencies and enhance the validated tasks/competencies related to identifying and starting a new business venture. Because the unit is a complement to certain designated courses and is not mandatory, all tasks/competencies are marked “optional.”

Appendix: Credentials, Course Sequences, and Career Cluster Information

Industry Credentials: Only apply to 36-week courses

- Associate Certified Electronics Technician (CETa) Examination
- College and Work Readiness Assessment (CWRA+)
- Electronics Application/Electronics Technology Examination
- Electronics Technology Assessment
- National Career Readiness Certificate Assessment
- Student Electronics Technician (SET) Examination
- Workplace Readiness Skills for the Commonwealth Examination

Concentration sequences: *A combination of this course and those below, equivalent to two 36-week courses, is a concentration sequence. Students wishing to complete a specialization may take additional courses based on their career pathways. A program completer is a student who has met the requirements for a CTE concentration sequence and all other requirements for high school graduation or an approved alternative education program.*

- Electronics Systems I (8416/36 weeks)
- Electronics Systems III (8413/36 weeks)
- Technology of Robotic Design (8420/18 weeks)
- Technology of Robotic Design (8421/36 weeks)

Career Cluster: Science, Technology, Engineering and Mathematics	
Pathway	**Occupations**
Engineering and Technology	**Computer Hardware Engineer** **Computer Software Engineer** **Electrical Engineer** **Electrical Engineering Technician** **Electronics Engineering Technician** **Network and Computer Systems Administrator** **Network Systems and Data Communication Analyst**