CareerClusters™ PATHWAYS TO COLLEGE & CAREER READINESS
Transportation, Distribution & Logistics

Learning that works for Colorado CTE®

Colorado CTE Course – Scope and Sequence

Course Name	Electronics- Solid State/Semiconductor	Course Details Course = 0.50 Carnegie Unit Credit	Credit = 0.5
Course Description	The course is an introduction to semiconductor fundamentals and applications to the electronic devices. Course creates the background in the physics of the compound semiconductor-based electronic devices and also prepare students to advanced courses in solid state and quantum electronics. The course provides an opportunity for students to continue education in undertaking advanced study and research in the variety of different branches of semiconductor device applications. Topics include the background solid state and semiconductor physics, and basic principles of electronic devices operation including diodes, transistors, and FETs, SCRs and UJTs. The hands-on laboratory portion of this course compares different type devices and their characteristics with emphasis on real life circuits and applications. (This course coves all competencies of ELT 134.)		
Note:	This is a suggested scope and sequence for the course content. The content will work with any textbook or instructional resource. If locally adapted, make sure all essential knowledge and skills are covered.		
SCED Identification #	17109	Schedule calculation based on 60 calendar days of a 90-day semester. Scope and sequence allows for additional time for guest speakers, student presentations, field trips, remediation, or other content topics.	

All courses taught in an approved CTE program must include Essential Skills embedded into the course content. The Essential Skills Framework for this course can be found at **https://www.cde.state.co.us/standardsandinstruction/essentialskills**

Instructional Unit Topic	Suggested Length of Instruction	CTE or Academic Standard Alignment	Competency / Performance Indicator	Outcome / Measurement	CTSO Integration
Career Exploration		Integrate multiple sources of career information from diverse formats to make informed career decisions, solve problems, and manage personal career plans.	The student demonstrates the skills necessary for success in a technical career. The student is expected to: (A) identify training, education, employment, and career opportunities, including differences between an electronic technician, electronic technologist, avionic	Update materials from coursework to add to the student's portfolio. Continually reflect on coursework experiences and revise and refine the career plan generated in prior courses. Include photographs or illustrations and written descriptions of sequential progress in projects.	

			technician, and electrical engineer; (B) identify employment and career opportunities; (C) identify industry certifications; (D) discuss ethical issues related to electronics and incorporate proper ethics in submitted projects; (E) identify and demonstrate respect for diversity in the workplace; (F) identify appropriate actions and consequences relating to discrimination, harassment, and inequality; (G) explore electronics career and preparation programs; (H) explore career preparation learning experiences, including, but not limited to, job shadowing, mentoring, and apprenticeship training; and	Examine readiness for industry certification. Complete practice exams and certification applications. Investigate work-based learning and entry level employment requirements and opportunities. Conduct mock interviews, complete resume and practice job search skills. Investigate advanced training opportunities and requirements. Discuss employment expectations of the workplace. Investigate companies with high consumer ratings. Explore how they operate using high standards for ethic and customer relations. Identify employment laws relating to discrimination and harassment. Discuss the employ and employer's role in creating a positive, inclusive, and diverse workplace.	

			(I) discuss *Accreditation Board for Engineering and Technology* (ABET) accreditation and implications. Student in aviation pathways should also: (J) Understand FAA knowledge test requirements of Aviation Maintenance Technicians and Aviation Electronics Technicians.		
Safety		Identify and apply acceptable strategies for the safe operation of electrical components and systems.	The student practices safe and proper work habits. The student is expected to: (A) master relevant safety tests; (B) comply with safety guidelines as described in various manuals, instructions, and regulations; (C) identify governmental and organizational regulations for health and safety in the workplace related to electronics;		

			(D) identify and classify hazardous materials and wastes according to Occupational Safety and Health Administration (OSHA) regulations and industry standards; (E) dispose of hazardous materials and wastes appropriately; (F) perform maintenance on selected tools, equipment, and machines; (G) handle and store tools and materials correctly; and (H) describe the results of negligent or improper maintenance of material, tools, and equipment.		
Crystals		Understand and apply knowledge of the physical and chemical properties of crystals used in electronic components and technology.	Understand and apply knowledge of the physical and chemical properties of crystals used in electronic components and technology. Student is expected to: (A) Understand and apply concepts related to		

			crystalline properties of solids (structure of crystals, unit cell, Wigner-Seitz cell, Bravais lattice, crystal systems, symmetry properties, point groups, space groups, Miller indices, packing factor, reciprocal lattice, Brillouin zone); and (B) Understand and apply concepts related to electrons and energy band structures in crystals (Bloch theorem, Kronig-Penney model, energy bands, nearly-free electron approximation, tight binding approximation, dynamics of electrons in a crystal, Fermi energy, Fermi distribution, density of states (3D), electrons		

			and holes, first Brillouin zone, band structures in metals).		
Diode Characteristics		Identify and explain the purpose of the diode elements and explain their operation.	Identify and explain the purpose of the diode elements and explain their operation. Student is expected to: (A) Identify and draw the schematic symbols for various diodes; (B) Identify and analyze the diode's operation with forward and reverse; (C) Recognize, draw, and label a balanced and ionized atom; (D) Name and utilize the effects of electron doping; and (E) Name and define the role of the acceptor and the donor atom.		
Semiconductor Fundamentals: The pn junction		Understand and apply concepts of semiconductors to electronic components and systems.	Understand fundamental concepts of electrical properties and semiconductors. Student is expected to: (A) Understand and apply concepts		

			related to equilibrium electrical properties of semiconductors: density of states, effective density of states, mass action law, intrinsic and extrinsic semiconductors, charge neutrality, n-type doping, p-type doping, Fermi energy, Fermi integral, electron and hole concentration; (B) Understand and apply concepts related to Non-equilibrium electrical properties of semiconductors: drift, drift current, Ohm's law, resistivity, conductivity, carrier collision and scattering, Hall effect, Lorentz force, mobility, diffusion, diffusion current, diffusion length,		

			Einstein relations, carrier generation and recombination mechanisms (Shockley-Read-Hall, Auger, surface re-combinations), carrier lifetime, capture cross section, quasi-Fermi energy; (C) Understand and apply concepts related to Semiconductor p-n and metal-semiconductor junctions: ideal p-n junction, built-in potential, drift and diffusion currents, depletion width, forward bias, reverse bias, ideal diode equation, minority carrier lifetime, capacitance. forward bias deviations from the ideal p-n junction case, breakdown,		

			avalanche breakdown, Zener breakdown, metal-semiconductor junctions, ohmic and Schottky contacts; (D) Identify and describe N-type and P-type materials; (E) Identify and define major and minor current carriers; (F) Trace the current flow in a solid state PN junction diode; (G) Recognize and label the schematic symbol of the PN junction diode; (H) Test and analyze the diode with forward and reverse bias conditions; (I) Recognize, test, analyze, and compare the diode for forward and reverse resistance; and		

			(J) List and apply the ratings and nomenclature of the diode.		
Transformers and Transistors: **1. Rectifier circuits** **2. Power supply circuits** **3. Regulator circuits** **4. Junction transistors** **5. Characteristic curves and transistor circuits** **6. Common emitter** **7. Common collector** **8. Common base** **9. Temperature effect**		Identify and apply the operating principles of transformers and rectifiers when accomplishing aircraft maintenance.	Understand and apply concepts related to transformers and transistors. Student is expected to: (A) Understand terminology and concepts related to amplification and switching, bipolar junction transistor (BJT) principles, amplification process, electrical charge distribution and transport, current gain, deviations from ideal BJT case, heterojunction bipolar transistors, junction field effect transistors (JFET), metal-oxide-semiconductor field effect transistor (MOSFET), deviations from		

			the ideal MOSFET case, application specific transistors; (B) Identify, test, and analyze the half wave rectifier circuit, conventional fullwave bridge rectifier, and the clipper or limiter circuit; (C) Identify, construct, test, and evaluate the simple cap lifter circuit, the L and Pi type filter circuits; (D) Identify, construct, test, analyze, and compare the characteristics and operation of the zener diode regulator circuit and the series regulator circuit; (E) Identify, construct, test, analyze, and compare the characteristics and operation of the shunt regulator circuit;		

			(F) Recognize the types of transistors and identify the elements associated with transistors; (G) Apply the correct junction bias; (H) List the leg-current relationships in transistors; (I) Identify the symbols and subscripts associated with transistors; and (J) Name the advantages and disadvantages of transistors.		
Advanced Electronic Concepts		Apply understanding of Advanced Electronic Theory and Concepts.	The student implements the concepts and skills that form advanced knowledge of electronics using project-based rubrics. The student is expected to: (A) apply Ohm's law, Kirchhoff's laws, and power laws to advanced circuit theory; (B) demonstrate advanced knowledge of the theory of direct		

			current, alternating current, digital circuits, and semi-conductor circuits through Thevenin and Norton's theorems; (C) apply knowledge of voltage regulation devices; (D) apply knowledge of the design and use of diodes, transistors, and analog components with integrated circuits; (E) implement knowledge of solid-state components and devices such as a power supply design; (F) demonstrate knowledge of the similarities and differences in optoelectronic devices; (G) implement knowledge of transmission theory; (H) implement knowledge of microprocessor applications;		

			(I) apply electronic theory to generators, electric motors, power supplies, electronic amplifiers, electronic oscillators, communication circuits, and systems; and (J) complete advanced electrical-electronic troubleshooting assignments to industry standards.		
Tools and Equipment		Apply knowledge of tools and equipment used in electronic installation, repair, maintenance, and analysis.	The student learns the function and application of the tools, equipment, and materials used in electronics through specific project-based assessments. The student is expected to: (A) use tools and laboratory equipment in a safe manner to construct and repair circuits; (B) use precision measuring instruments to analyze circuits and prototypes; (C) describe and perform measurement techniques		

			with analog, digital, or storage oscilloscopes; (D) use multiple software applications to simulate circuit behavior and present concepts; and (E) identify and describe the functions of computer hardware devices.		
Circuit Design		Identify and apply aviation industry standards during the installation, inspection and repair of electrical wiring and circuit devices. Read and interpret aircraft electrical circuit diagrams for various systems.	The student designs and inspects products using appropriate processes and techniques. The student is expected to: (A) read and interpret technical drawings, manuals, and bulletins; (B) interpret advanced industry standard schematics; (C) use a variety of technologies to inspect and repair components such as computer		

			simulation software; and (D) explore innovative technologies that may affect electronics; (E) Identify and practice proficiency utilizing the basic configurations; (F) Recognize and use circuits utilizing the classes of bias; (G) Identify and explain the component functions of CE circuit; (H) Draw a load line on the collector curves using the parameters of the circuit; (I) Determine the major characteristics; (J) Demonstrate proficiency utilizing different methods of bias; and (K) Determine and demonstrate proficiency		

			utilizing AC conditions.		
Measurement & Analysis		Identify and implement acceptable strategies for analyzing and troubleshooting electrical circuits including position and warning systems, power distribution circuits, and basic solid state devices using logic functions.	Identify and implement acceptable strategies for analyzing and troubleshooting electrical circuits including position and warning systems, power distribution circuits, and basic solid state devices using logic functions. Student is expected to: (A) Identify and use common electrical symbols during the basic analysis of basic electrical circuits; (B) Test transistors to determine if defective. (C) Interpret collector curves. (D) Calculate and use circuit analysis principles on CE circuits; (E) Analyze and test circuits with large signal behavior; (F) Analyze and demonstrate proficiency utilizing small		

			signal parameters; (G) Analyze and measure the characteristics of the circuit; (H) Calculate and practice utilizing Q-point analysis; (I) Describe and list typical leakage currents in germanium and silicon transistors; (J) Explain how to stabilize CE, CB, and CC circuits; (K) Define stability factor; (L) Calculate the maximum power dissipated at the collector; and (M) Derate a transistor.		
