Electronics Analog/Robotics - AES

Level: 3
Career Cluster: Advanced Manufacturing
Program: Engineering
Pathway(s): Aerospace Engineering Technician

Course Catalog Description

Introduces students to analog electronics and robotics through hands-on circuit design, testing, and system integration with an emphasis on aerospace systems and avionics-related applications. Students build skills in measurement, programming, troubleshooting, and technical analysis while exploring how electronic and robotic systems support aircraft, spacecraft, drones, and other aerospace technologies.

Summary

This course provides students with an in-depth study of analog electronics and robotics through career exploration, safe laboratory practice, and hands-on application of engineering concepts in aerospace contexts. Students examine foundational principles such as voltage, current, resistance, power, circuit behavior, inductive and capacitive reactance, rectification, voltage regulation, semiconductor devices, and amplification while constructing, testing, and refining circuits using breadboards, meters, and other electronic tools. Throughout the course, students analyze schematics, measure and evaluate circuit performance, and apply technical reasoning to troubleshoot and improve both analog systems and robotic subsystems. Students also integrate electronics into robotics platforms, develop simple programming and control logic, and demonstrate how circuit design, signal flow, sensing, and programming work together to support aerospace-relevant functions such as avionics interfaces, drone subsystems, automated inspection, environmental monitoring, and mission task execution. Emphasis is placed on professionalism, technical communication, postsecondary and career opportunities in aerospace engineering technician pathways, and the ability to present and justify final design solutions using evidence gathered through testing and iterative refinement.

Notes

This updated version more clearly organizes instruction into sequenced student outcome sections and intentionally reframes the content through an aerospace engineering technician lens. The revised course places stronger emphasis on analog electronics concepts such as circuit analysis, series and parallel behavior, reactance, rectification, voltage regulation, semiconductor devices, amplification, breadboarding, and measurement/testing practices. It also more explicitly connects electronics learning to robotics integration, programming, troubleshooting, and final application tasks, helping students see how circuits and control systems function together in aerospace-relevant contexts such as avionics, drones, sensing, and automated systems. Overall, the updated document provides a more structured, pathway-specific progression that better aligns electronics and robotics content with aerospace applications, technical skill development, and career readiness.

Student Learning Outcomes

1. Career Exploration and Postsecondary Opportunities

Objective: *Students will analyze career pathways in aerospace engineering technician by exploring industry roles, workplace expectations, required education, certifications, professional organizations, and postsecondary opportunities available in Colorado in order to make informed academic and career decisions.*

1) Identify employment opportunities in various fields with a focus in the area of aerospace engineering technician
    a. Recognize the work typically performed, tools and technology used, and nature of work environments
    b. Identify potential certifications within the careers
    c. Find membership organizations associated with the careers
    d. Understand the necessary education associated within the careers
2) Define professionalism within the context of aerospace engineering technician
    a. Criticism and evaluation
    b. Presentation
    c. Assessment
3) Recognize laws, regulations, and ethics significant to the fields of aerospace engineering technician
4) Identify postsecondary opportunities offered in the state of Colorado
    a. Technical college, community college, 4-year institutions
    b. Certificates, associates, bachelor, and advanced degree opportunities

2. Safety and Electronics Laboratory Practice

Objective: *Students will apply safe work habits, proper tool use, and responsible lab procedures to prevent hazards while working with analog electronic, robotic, and aerospace-related systems.*

5) Interpret electrical and laboratory safety rules related to analog electronics, robotics, and aerospace system work
6) Demonstrate safe use of breadboards, power supplies, meters, and hand tools
7) Identify hazards associated with electrical current, heat, polarity, exposed conductors, and sensitive aerospace electronics
8) Apply proper procedures for organizing and maintaining a safe electronics workstation
9) Evaluate laboratory practices for compliance with safety expectations

3. Analog Electronics Fundamentals and Circuit Concepts

Objective: *Students will explain foundational analog electronics concepts in order to analyze current flow, voltage behavior, and circuit operation.*

11) Define voltage, current, resistance, and power using correct units and symbols
12) Differentiate analog and digital signals in engineering systems
13) Explain how energy flows through basic electronic systems

14) Interpret simple electronic schematics and standard circuit symbols
15) Analyze the relationship between components and circuit behavior

4. Series Parallel and Combination Circuit Analysis

Objective: *Students will analyze and construct series, parallel, and combination circuits to determine how circuit configuration affects performance.*

17) Identify the characteristics of series, parallel, and combination circuits
18) Construct working circuits that model each configuration
19) Apply circuit laws and formulas to calculate voltage, current, resistance, and power
20) Compare how current and voltage behave across different circuit arrangements
21) Evaluate circuit performance using calculated and measured values

5. Inductive and Capacitive Reactance

Objective: *Students will analyze how inductors and capacitors influence circuit behavior in changing electrical conditions.*

22) Define capacitance, inductance, and reactance
23) Describe how capacitors and inductors store and release energy
24) Compare resistive behavior with reactive behavior in circuits
25) Interpret how frequency affects capacitive and inductive response
26) Analyze the role of reactive components in circuit timing, filtering, and energy transfer
27) Evaluate circuit behavior when reactive components are added or modified

6. Power Conversion Rectification and Voltage Regulation

Objective: *Students will examine and apply power conversion methods used to transform and stabilize electrical energy in electronic systems.*

28) Explain the purpose of rectification in electronic systems
29) Identify the function of diodes in converting AC to DC
30) Construct simple rectifier circuits using appropriate components
31) Describe the purpose of voltage regulation in protecting and stabilizing circuits
32) Analyze how regulated and unregulated power supplies affect system performance
33) Evaluate power conversion circuits for reliability and effectiveness

7. Semiconductor Devices and Analog Components

Objective: *Students will explain the function of semiconductor devices and apply them in analog circuits used in robotics, avionics, and aerospace control systems.*

34) Identify common semiconductor devices including diodes and transistors
35) Describe how semiconductor materials differ from conductors and insulators
36) Explain how semiconductor devices control current and signal flow
37) Construct circuits that use semiconductor components for switching or control
38) Analyze the effect of component selection on circuit behavior
39) Evaluate the reliability of semiconductor-based circuit designs

8. Amplification and Signal Conditioning

Objective: *Students will analyze signal amplification and conditioning techniques in order to improve circuit performance for practical robotics, sensor, and aerospace applications.*

40) Define amplification and explain why it is used in analog systems
41) Identify basic amplifier functions in electronic and robotic applications
42) Analyze how input signals are modified by amplification stages
43) Construct introductory analog circuits that demonstrate gain or signal change
44) Compare strong and weak signals in system performance
45) Evaluate signal quality and circuit response during testing

9. Breadboarding Prototyping and Circuit Construction

Objective: *Students will construct and test analog electronic circuits using breadboards and standard prototyping methods.*

46) Identify the structure and function of a breadboard
47) Assemble analog circuits according to a schematic or design plan
48) Use polarity-sensitive components correctly during construction
49) Test circuits for continuity, proper function, and safe operation
50) Modify prototype circuits based on observed results
51) Evaluate circuit layout for organization, accuracy, and reliability

10. Measurement Testing and Technical Analysis

Objective: *Students will use test equipment to measure, interpret, and communicate circuit behavior accurately.*

52) Operate multimeters and other relevant test equipment safely and correctly
53) Measure voltage, current, and resistance in analog circuits
54) Collect and organize data from circuit tests and trials
55) Compare measured values to expected circuit behavior
56) Analyze results to determine circuit performance and error sources
57) Communicate findings using precise technical language, tables, or lab notes

11. Robotics Electronics Integration

Objective: *Students will integrate analog electronic concepts into robotic and aerospace systems in order to explain how circuits support motion, sensing, monitoring, and control.*
58) Identify the electronic subsystems that support robotic and aerospace system operation
59) Explain how analog circuits provide power or signal support in robotic, drone, or avionics-related systems
60) Integrate electronic components into a robotics platform or aerospace-relevant subsystem
61) Analyze how electronic design decisions affect system performance
62) Test subsystems for proper operation
63) Evaluate system performance based on reliability, responsiveness, and function

12. Robotic Programming and Task Control

Objective: *Students will develop and refine programs that enable a robot or aerospace-relevant device to perform a specific task using integrated electronic and control components.*

64) Define the purpose of programming in robotic task execution
65) Develop simple control logic for a robot to complete a defined action
66) Program a robot to respond to commands, conditions, or inputs
67) Test robotic programs for functional accuracy and repeatability
68) Revise code and control logic to improve performance
69) Evaluate how programming and electronics work together in robotic systems

13. Troubleshooting Design Refinement and Final Application

Objective: *Students will diagnose, refine, and present an analog electronics, robotics, or aerospace systems solution that demonstrates mastery of course concepts.*

70) Identify common faults in analog circuits and robotic subsystems
71) Apply a systematic troubleshooting process to isolate problems
72) Analyze testing evidence to determine the cause of malfunction
73) Revise designs, wiring, or programming to improve performance
74) Document troubleshooting steps, modifications, and final outcomes
75) Present a completed system and justify design decisions using technical evidence
76) Reflect on learning growth, design challenges, and system improvements

14. Leadership

Objective: *Students will apply leadership skills, collaboration strategies, and professional responsibility to contribute effectively in classroom, laboratory, CTSO, and project-based settings.*

77) Demonstrate leadership behaviors such as initiative, accountability, and ethical decision-making
78) Collaborate effectively with peers to plan, organize, and complete team tasks
79) Apply conflict-resolution and communication strategies in group and project settings
80) Participate in leadership development opportunities through CTSO or related activities
81) Evaluate personal leadership strengths and areas for growth based on feedback and reflection

15. Work-Based Learning

Objective: *Students will connect classroom learning to workplace expectations by exploring work-based learning experiences, employability skills, and professional practices relevant to aerospace engineering technician pathways.*

82) Identify the purpose and value of work-based learning experiences in career preparation
83) Demonstrate employability skills such as punctuality, communication, teamwork, and problem-solving
84) Describe expectations and responsibilities associated with internships, job shadows, apprenticeships, or industry mentorships

85) Apply professional workplace behaviors in authentic industry contexts
86) Reflect on work-based learning experiences to identify skills gained and career interests

16. Career and Technical Student Organizations

Objective: *Using the CTSO Resource Document, chapter activities will provide some of the best opportunities CTSO members will have to learn by doing. A successful program of work creates a positive learning atmosphere in the classroom. CTSO members learn how to accept responsibility, work as a team, manage a budget, and handle success and failure. Per the CTE Admin Handbook, CTSOs are embedded into curriculum.*

Professional Development

Prepare each member for entry into the workforce and provide a foundation for success in a career. Becoming a professional does not stop with acquiring a skill, but involves an increased awareness of the meaning of good citizenship and the importance of labor and management in the world of work.

Community Service

Promote and improve goodwill and understanding among all segments of the community through services donated by CTSO chapters, and to instill in its members a lifetime commitment to community service.

Business and Industry Connections

Increase awareness of quality job practices and attitudes, and increase the opportunities for employer engagement and eventual employment.

Financial Leadership

Plan and participate in activities to allow all members to carry out the chapter's projects. Educate members on their own personal finance for current and future success.

Public Relations

Make the general public aware of the good work that students in career and technical education are doing to better themselves and their community, state, nation, and world.

Social Activities

To increase cooperation in the school and community through activities that allow CTSO members to get to know each other in something other than a business or classroom setting.

Academic Standards Alignment

Colorado CTE courses are required to integrate academic and essential skills into course content. The following academic standards have been identified as aligned to this course and should be integrated throughout instruction.

CO CTE Academic Standards Resources (Rubrics, integration strategies, etc)
CDE Colorado Academic Standards Online (Online standards lookup tool)

Note: Mathematics and Science standards will be added in the future. Visit the Colorado Academic Standards page for the most current version.

Reading, Writing and Communicating Crosswalk

Course: Electronics Analog/Robotics
Colorado Academic Standards – Reading, Writing, and Communicating

Standard	Prepared Graduate Competency	Description	Course Evidence / Alignment
Standard 1: Oral Expression and Listening	Prepared Graduate 1 – Collaboration	Collaborate effectively as group members or leaders.	Students work collaboratively while building, testing, and troubleshooting analog circuits, robotic systems, and aerospace-relevant subsystems; communicate procedures, safety practices, and findings within lab teams.
Standard 1: Oral Expression and Listening	Prepared Graduate 2 – Oral Presentations	Deliver effective oral presentations for varied audiences and varied purposes.	Students verbally explain circuit behavior, component function, and control logic; communicate system design choices and troubleshooting outcomes; and present robotics or aerospace-focused projects and

			demonstrations using appropriate technical language.
Standard 2: Reading for All Purposes	Prepared Graduate 4 – Informational Texts	Read a wide range of informational texts to build knowledge.	Students read and interpret electronics diagrams, schematics, and lab manuals; technical documentation related to analog components, robotics systems, and aerospace electronics; and safety rules and regulatory guidelines from industry sources.
Standard 2: Reading for All Purposes	Prepared Graduate 5 – Language in Context	Understand how language functions in different contexts.	Students accurately use electronics-, robotics-, and aerospace-specific vocabulary, interpret symbols, abbreviations, and conventions used in electrical schematics, and adjust language appropriately for technical explanation, safety, and documentation contexts.
Standard 3: Writing and Composition	Prepared Graduate 6 – Craft arguments	Craft arguments using techniques specific to the genre.	Students justify design and wiring decisions using electronic theory, defend troubleshooting choices based on observed circuit performance, and support conclusions with data from

			testing and robotics task execution.
Standard 3: Writing and Composition	Prepared Graduate 7 – Informational Writing	Craft informational/explanatory texts using techniques specific to the genre.	Students produce written explanations of analog circuit behavior, documentation describing robotic programming logic and system integration, and explanatory lab reports detailing results and performance.
Standard 3: Writing and Composition	Prepared Graduate 9 – Writing Process	Demonstrate mastery of their own writing process.	Students draft, revise, and finalize lab reports and technical documentation; use correct terminology, symbols, and formatting; and produce clear, coherent, and accurate written work aligned to industry expectations.
Standard 4: Research Inquiry and Design	Prepared Graduate 10 – Research and Ethics	Gather information from a variety of sources; analyze and evaluate its quality and relevance.	Students research electronic components, robotics applications, aerospace systems, and system requirements; analyze technical data to improve circuit performance and device behavior; and use information ethically to support safe, effective system design and operation.

Free Resource Links

1. Career Exploration and Postsecondary Opportunities in Aerospace

- FAA Aviation Workforce and Education Programs (aviation aerospace career pathways student programs) https://www.faa.gov/education/programs
- NASA Learning Resources (aerospace careers internships student pathways) https://www.nasa.gov/learning-resources/
- FAA High School Programs (engineering challenge aerospace exploration) https://www.faa.gov/education/programs/highschool
- Colorado Space Grant Consortium (Colorado aerospace projects postsecondary opportunities) https://www.colorado.edu/center/spacegrant/

2. Safety and Electronics Laboratory Practice for Aerospace Systems

- FAA Educators Guide Our Future Stars (aviation aerospace lesson resources safety awareness) https://www.faa.gov/education/educators
- OSHA (electronics lab safety electrical hazards prevention) https://www.osha.gov/
- FAA Additional Resources for Aviation and Aerospace (student educator aerospace reference links) https://www.faa.gov/education/students/resources
- CDC NIOSH (engineering safety workplace hazards prevention) https://www.cdc.gov/niosh/

3. Analog Electronics Fundamentals and Circuit Concepts

- All About Circuits (analog electronics fundamentals voltage current basics) https://www.allaboutcircuits.com/
- Electronics Tutorials (analog circuits principles components basics) https://www.electronics-tutorials.ws/
- Khan Academy Electrical Engineering (voltage current resistance fundamentals) https://www.khanacademy.org/science/electrical-engineering
- SparkFun Learn (analog electronics basics circuits learning) https://learn.sparkfun.com/

4. Series Parallel and Combination Circuit Analysis

- All About Circuits DC (series parallel circuit analysis fundamentals) https://www.allaboutcircuits.com/
- Electronics Tutorials DC (series parallel combination circuits) https://www.electronics-tutorials.ws/dccircuits/
- Khan Academy Circuits (circuit analysis ohms law applications) https://www.khanacademy.org/science/electrical-engineering
- CircuitLab (circuit simulation series parallel analysis) https://www.circuitlab.com/

5. Inductive and Capacitive Reactance

- Electronics Tutorials Reactance (inductive capacitive reactance ac circuits) https://www.electronics-tutorials.ws/accircuits/reactance.html

- All About Circuits AC (reactance capacitors inductors behavior) https://www.allaboutcircuits.com/
- Electrical4U Reactance (inductors capacitors ac circuit theory) https://www.electrical4u.com/
- Khan Academy Waves (frequency reactive components concepts) https://www.khanacademy.org/science/physics

6. Power Conversion Rectification and Voltage Regulation

- Electronics Tutorials Diodes (rectification voltage regulation power supplies) https://www.electronics-tutorials.ws/diode/
- All About Circuits Power (power supply circuits rectification) https://www.allaboutcircuits.com/
- Learn About Electronics Diodes (rectifiers voltage regulation circuits) https://www.learnabout-electronics.org/
- Electrical4U Rectifiers (power conversion ac to dc systems) https://www.electrical4u.com/

7. Semiconductor Devices and Analog Components

- Electronics Tutorials Semiconductors (diodes transistors basics) https://www.electronics-tutorials.ws/
- All About Circuits Components (semiconductor devices applications circuits) https://www.allaboutcircuits.com/
- Learn About Electronics Semiconductors (diodes transistors devices explanation) https://www.learnabout-electronics.org/
- SparkFun Components Guide (electronics components semiconductor basics) https://learn.sparkfun.com/

8. Amplification and Signal Conditioning

- All About Circuits Amplifiers (signal amplification analog electronics) https://www.allaboutcircuits.com/
- Electronics Tutorials Amplifiers (amplification gain signal circuits) https://www.electronics-tutorials.ws/
- Learn About Electronics Amplifiers (signal conditioning amplification circuits) https://www.learnabout-electronics.org/
- Khan Academy Signals (signal processing amplitude fundamentals) https://www.khanacademy.org/science/electrical-engineering

9. Breadboarding Prototyping and Circuit Construction

- SparkFun Breadboard Guide (breadboarding prototyping electronics circuits) https://learn.sparkfun.com/tutorials/how-to-use-a-breadboard
- Adafruit Learning System (electronics prototyping project circuits) https://learn.adafruit.com/
- Tinkercad Circuits (virtual circuit prototyping simulation) https://www.tinkercad.com/circuits

- Digi Key Tutorials (breadboarding and circuit construction basics) https://www.digikey.com/en/resources

10. Measurement Testing and Technical Analysis

- Fluke Learn (electrical measurement test equipment fundamentals) https://www.fluke.com/en-us/learn
- Tektronix Education (oscilloscope measurement signal analysis) https://www.tek.com/en/education
- Keysight Learn (electronic testing measurement systems analysis) https://www.keysight.com/us/en/learn.html
- NI LabVIEW Resources (data acquisition measurement analysis tools) https://www.ni.com/en-us/shop/labview.html

11. Robotics Electronics Integration for Aerospace Applications

- NASA Aeronautics STEM (aeronautics engineering design advanced air mobility classroom resources) https://www.nasa.gov/aeronautics/aeronautics-stem/
- FAA Aviation and Space Education (aerospace pathways K12 educator support) https://www.faa.gov/education
- Arduino Education (robotics electronics integration programming hardware) https://www.arduino.cc/education
- The Aerospace Corporation Teacher Resources (robotics satellites aerospace systems lessons) https://aerospace.org/stem/teacher-resources

12. Robotic Programming and Task Control for Aerospace Devices

- Arduino Programming (robot control coding electronics systems) https://www.arduino.cc/
- Khan Academy Programming (coding fundamentals logic robotics control) https://www.khanacademy.org/computing
- Scratch Programming (intro robotics programming logic control) https://scratch.mit.edu/
- Carnegie Mellon Robotics Coding (robot programming system control) https://www.cmu.edu/roboticsacademy/

13. Troubleshooting Design Refinement and Final Application

- iFixit (troubleshooting diagnostics repair processes systems) https://www.ifixit.com/
- All About Circuits Troubleshooting (circuit diagnostics fault analysis) https://www.allaboutcircuits.com/
- Fluke Troubleshooting (electrical troubleshooting measurement analysis) https://www.fluke.com/en-us/learn
- Engineering Toolbox (engineering problem solving system optimization) https://www.engineeringtoolbox.com/

14. Leadership

- National Coordinating Council for Career and Technical Student Organizations (CTSO leadership employability skills career readiness)
  https://www.ctsos.org/
- NACE Career Readiness Competencies (leadership professionalism teamwork communication)
  https://www.naceweb.org/docs/default-source/default-document-library/2024/resources/nace-career-readiness-competencies-revised-apr-2024.pdf?sfvrsn=1e695024_3
- A Guide for Effective Teamwork - University of Nebraska (teamwork collaboration group projects communication skills)
  https://teaching.unl.edu/resources/strategies-techniques/teamwork/

15. Work-Based Learning

- SkillsUSA Work-Based Learning (career readiness internships job shadowing employability skills)
  https://www.skillsusa.org/students/work-based-learning/
- CareerOneStop (career exploration training job search student career readiness)
  https://www.careeronestop.org/
- Colorado Work-Based Learning Definitions (job shadowing internships apprenticeships career pathways)
  https://dhr.colorado.gov/work-based-learning-skills-based-hiring/state-agency-work-based-learning-definitions
- U.S. Department of Labor Career Preparation and Work-Based Learning Experiences (internships job readiness employability planning)
  https://www.dol.gov/agencies/odep/program-areas/individuals/youth/career-preparation

Technology Student Association – National Competitive Events

Robotics

Objective: *Students will design, build, test, operate, document, and explain a robot that completes the annual TSA Robotics challenge within competition requirements.*

- Analyze the annual TSA Robotics challenge and identify required tasks, constraints, safety considerations, and scoring criteria.
- Design and construct a robot that integrates mechanical, electrical, control, and structural systems.
- Program or configure the robot to complete required challenge tasks.
- Test robot performance before competition and make adjustments to improve reliability, control, and task completion.
- Operate the robot during the timed challenge while following TSA event procedures.
- Document the robot's design, construction, testing, revisions, and team problem-solving process.
- Participate in a team interview explaining robot systems, design decisions, programming or control strategies, and performance results.

Resources

- Technology Student Association – Robotics competition guidelines
  https://tsaweb.org/competitions-programs/tsa/themes-problems
- VEX Robotics STEM Labs
  https://education.vex.com/
- Arduino Education – Robotics and electronics resources
  https://www.arduino.cc/education
- FIRST Robotics Resource Library
  https://www.firstinspires.org/resource-library

Technology Student Association – National Competitive Events

System Control Technology

Objective: *Students will design, construct, program, troubleshoot, document, and demonstrate a working control-system solution that responds to a TSA-provided problem.*

- Interpret the TSA-provided control-system problem and identify the required functions, constraints, and performance goals.
- Design a system that uses inputs, outputs, circuits, sensors, motors, controls, feedback, or programmable components.
- Create a program or control sequence that allows the system to operate as intended.
- Construct and test the system using approved materials, tools, electronics, and safety procedures.
- Troubleshoot mechanical, electrical, sensor, programming, or feedback-loop issues to improve system performance.
- Maintain an inventor's log documenting design decisions, testing, revisions, and final system operation.
- Demonstrate the completed system and explain how the design meets the problem criteria during judge evaluation.

Resources

- Technology Student Association – System Control Technology competition guidelines https://tsaweb.org/competitions-programs/tsa/themes-problems
- Arduino Education – Electronics and control systems https://www.arduino.cc/education
- Tinkercad Circuits – Circuit simulation and prototyping https://www.tinkercad.com/circuits
- VEX Robotics STEM Labs – Mechanisms, sensors, and programming https://education.vex.com/

Technology Student Association – National Competitive Events

Animatronics

Objective: *Students will design, construct, control, document, and present an animatronic device that meets TSA requirements for movement, control technology, lights, sound, sensors, and mechanical systems.*

- Research the annual TSA Animatronics theme and develop an original animatronic concept.
- Design an animatronic device that integrates structure, motion, control, and presentation elements.
- Construct an exterior shell or skin that can be removed to show internal components to judges.
- Incorporate multiple movements using mechanisms such as linkages, gearing, cabling, fluid power, or related systems.
- Integrate control technology, sensors, lights, sound, motors, or electronic components into the animatronic model.
- Test and troubleshoot the device for reliable operation, safe power use, appropriate movement, and presentation readiness.
- Present the animatronic device and explain the design process, internal components, control system, and final performance.

Resources

- Technology Student Association – Animatronics competition guidelines https://tsaweb.org/competitions-programs/tsa/themes-problems
- Arduino Education – Sensors, lights, and control systems https://www.arduino.cc/education
- Adafruit Learning System – Electronics, LEDs, sensors, and microcontrollers https://learn.adafruit.com/
- Instructables Circuits – Electronics and animatronics project examples https://www.instructables.com/circuits/