Earth Systems Science

Common Syllabus

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Course Overview

Course Description:
Earth Systems Science (ESS) is a project based and laboratory science course designed for incoming students to Lee Academy. Students will examine the biosphere, atmosphere, lithosphere, and hydrosphere as interconnected systems. Students will understand that earth systems are constantly in flux and reacting to feedback as they explore topics in ecology, geology, astronomy, climate science, and oceanography. The common themes of matter and energy cycling are woven throughout the course. At the end of the course, students will be aware of the interconnectedness of these two concepts. Students will also continue to develop the measurement, scientific problem solving, and communication skills needed to succeed in future science courses.

Course-Specific Expectations and Details:
Students taking ESS will be challenged to "think outside of the box" as they solve problems using inquiry and the scientific method. Projects and experiments will be taught using an inquiry approach, requiring students to ask questions and develop novel methods to study these problems. Students will be required to complete basic measurements and calculations, organize data in tables, graphs, and graphic organizers, write lab reports using the Lee Academy science department lab report format, and use technology to work in groups and present projects.

Next Generation Science Standards (NGSS) that are *ongoing* throughout this course:

HS-ESS2-2.	Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.
HS-ESS2-3.	Develop a model based on evidence of Earth's interior to describe the cycling of matter (adapted).*
HS-ESS2-6.	Develop a quantitative model to describe the cycling of *matter* among the hydrosphere, atmosphere, geosphere, and biosphere (adapted).*
HS-ESS3-6.	Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.
HS-ESS2-4.	Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate *and other earth systems* (adapted).
HS-LS2-3.	Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in *earth systems* (adapted).*
HS-LS2-4.	Use mathematical representations to support claims for the cycling of matter and flow of energy in *earth systems* (adapted)*.

Common Core Standards that are *ongoing* throughout this course:

CCSS.ELA-Literacy.RST.9-10.3
Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.
CCSS.ELA-Literacy.RST.9-10.4
Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.
CCSS.ELA-Literacy.RST.9-10.7
Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
CCSS.ELA-Literacy.WHST.9-10.1.e
Provide a concluding statement or section that follows from or supports the argument presented.
CCSS.ELA-Literacy.WHST.9-10.2.a
Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
CCSS.ELA-Literacy.WHST.9-10.6
Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.
CCSS.ELA-Literacy.WHST.9-10.7
Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
CCSS.ELA-Literacy.WHST.9-10.9
Draw evidence from informational texts to support analysis, reflection, and research.

Unit Outline

Unit	Learning Goals & Expected Outcomes Common Core/NGSS	Unit Description	Primary Texts, Internet & Media Resources, and Other Essential Content, Materials, and Equipment
First Semester			
Quarter 1	**Quarter 1**		
Unit 1: Forest Inventory Growth (FIG) Plots Number of 80-minute classes: 8	HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems. HS-LS2-2. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.	Students will collect and evaluate data in order to complete a FIG plot, evaluate the health of the forest based on their results, and share their findings in a lab report. During this unit, students will have to practice and apply basic measurement and observation skills, complete basic calculations, evaluate their results, and learn how to write a lab report. Students will develop an understanding of what a system is and how systems	• background information and data sheets from "Focus on Forests Activity 1 - Monitoring Forest Health", *Project Learning Tree,* https://www.plt.org/focus-on-forests-activity-1---monitoring-forest-health • "Forest Trees of

		are constantly in flux and react to change.	Maine", Maine Forest Service, 2008, 14th edition (tree ID guidebook) • 100 ft tape measures, tree diameter tapes, height gauges or clinometers, meter sticks, flagging tape, permanent markers, cameras, and calculators • access to technology to complete lab reports
Unit 2: Exploring Soils Number of 80-minute classes: 8	HS-ESS2-1. Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.	Students will complete quantitative and qualitative observations, including basic chemical analysis (soil pH) in order to evaluate soil conditions at the forest study sight. They will then infer how soil conditions are affecting forest health at the sight and evaluate how soil is a system of biotic and abiotic components. They will also complete a lab report for this activity.	• background information and soil data sheets from "Focus on Forests Activity 1 - Monitoring Forest Health", *Project Learning Tree,* https://www.plt.org/focus-on-forests-activity-1---monitoring-forest-health • soil texture and color guides • garden shovels/spades, soil corer, soil collection containers, pH meter and/or pH paper, • appropriate technology to complete lab reports
Unit 3: The Water Cycle Number of 80-minute classes: 7	HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.	Students will complete quantitative and qualitative observations in order to evaluate the hydrologic conditions at the study sight. They will infer how these conditions are affecting the forest health and soil conditions at the sight. Students	• hydrologic observation data sheet • area topographic maps • well depth recorder, 100 ft tape measure,

		will work in groups create a poster showing how the water cycle is occurring at and affecting the study sight and explain their poster to the class.	stream flow recorder • materials for posters
Quarter 2	**Quarter 2**		
Unit 4: Nutrient Cycles Number of 80-minute classes: 7	HS-ESS2-6. Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. HS-LS2-4. Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.	Students will develop an understanding of what elements and compounds are and how substances change through chemical reactions by examining the major nutrient cycles (carbon, nitrogen, and phosphorus). Students will be able to explain how nutrients change forms in these cycles and why different nutrient forms are important. During this unit, students will test local soils and waters for nutrients and explain their results and the implications of their results in a lab report.	• web-sites/handouts providing background information on basic chemistry and each nutrient cycle • data collection sheets • equipment for sample collection, nutrient test kits, and appropriate glassware for completing tests • safety goggles/gloves for chemical tests
Unit 5: **Changes in the Shape of the Earth** Number of 80-minute classes: 5	HS-ESS2-1. Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features. HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.	Students will evaluate the forces that shape the surface of the earth, including water, ice, wind, the sun, and living things. They will be able to explain what the forces are and how they act to change the earth's surface. At the end of the unit, students will be assigned a local land form to study. They will develop a short presentation explaining how this landform came to be the way it is today.	• web-sites/handouts providing background information on erosion/weathering • local topographic maps • web-sites providing information/pictures about local landforms • appropriate technology for presentations
Unit 6: The Rock Cycle Number of 80-minute classes: 6	HS-ESS2-1. Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.	Students will be given or will bring in a rock. They will determine what type of rock they have and how it was formed. They will then develop a presentation for the class, explaining how the rock was formed, what phase of the rock cycle the rock is a part of, and what would have to happen to the rock in order for the rock to change into a different phase of the rock cycle.	• web-sites/handouts providing background information on the rock cycle • various types of rocks • appropriate technology for presentations

Cumulative Semester Project: Cycles of Matter	HS-LS2-4. Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.	Students will put together a booklet or brochure which shows how matter is cycled in the local study area. Students will need to include both visual and written explanations of the physical and chemical changes that occur as matter is cycled. They must include information and ideas from each of the units completed in the first semester.	• information and teacher feedback from completed semester one units • materials and technology necessary to generate and print booklet or brochure
	Second Semester: Conservation of Energy		
Quarter 3	**Quarter 3**		
Unit 7: Plate Tectonics Number of 80-minute classes: 6	HS-ESS1-5. Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks. HS-ESS2-1. Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.	Students will develop an understanding of plate tectonics. They will be able to explain that the earth's surface is broken into several plates, which are constantly moving and changing. Students will also be able explain how and why these plates are moving. At the end of the unit students will generate a physical model which depicts the three primary plate movements and the surface changes associated with these movements.	• web-sites/handouts providing background information on plate tectonics • supplies necessary for building models (clay, paper, etc.)
Unit 8: Earth over Time Number of 80-minute classes: 5	HS-ESS2-7. Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth. HS-ESS1-6. Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history. HS-ESS1-5. Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.	Students will explore how the earth has changed over time and how major changes within the earth and on the earth's surface have shaped the earth. Students will examine the evidence that supports the earth's history and will develop an understanding of how scientists study this evidence. At the end of the unit students will generate a geologic timeline that shows changes that have occurred during each period and evidence of these changes.	• web-sites/handouts providing background information on the earth's history and geologic time-scale • materials and technology necessary to create time-scale
Unit 9: Forces and Energy in our solar system.	HS-ESS1-1. Develop a model based on evidence to illustrate the life span of the sun and	Students will understand how the sun produces energy and how the	• web-sites/handouts providing background

Number of 80-minute classes: 5	the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation. HS-ESS1-4. Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.	energy from the sun and forces associated with the sun's mass impact the solar system. They will induce how the current movement and position of planets and other objects in our solar system relate to these forces. Students will conduct experiments modeling these forces and complete a lab report to demonstrate their understanding of these relationships.	information on the properties of the sun and solar systems • materials for modeling labs: mass sets, balls of different masses, stop-watches, tape measures
Unit 10: Forces and Energy in our Universe Number of 80-minute classes: 6	HS-ESS1-2. Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe. HS-ESS1-3. Communicate scientific ideas about the way stars, over their life cycle, produce elements.	Students will develop an understanding of how our universe is constantly in flux and how we are aware of the changes. Students will analyze data collected by astronomers that provide evidence of the formation of and changes occurring in the universe. They will create a graphic organizer or other visual display to depict how these changes have and are occurring.	• web-sites/handouts providing background information on the properties, development of, and changes in the universe • access to school planetarium • materials to create graphic organizers
Quarter 4	**Quarter 4**		
Unit 11: Warming and Cooling of the Earth Number of 80-minute classes: 6	HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.	Students will develop an understanding of the physical and chemical structure of the atmosphere. They will then examine how the atmosphere influences conditions on earth. They will analyze how the atmosphere traps energy from the sun (greenhouse effect) through a series of labs and create a physical model of the atmosphere and greenhouse effect where they measure and collect temperature changes. They will analyze their data and share their results in a lab report.	• web-sites/handouts providing background information on the properties of the atmosphere • materials for greenhouse lab: 2-liter soda bottles or other clear containers, heat lamps, thermometers, baking soda and vinegar, sand, stop-watches. plastic wrap
Unit 12: Climate, the Oceans, and Weather Systems Number of 80-minute classes: 6	HS-ESS3-5. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems. HS-ESS2-5. Plan and conduct an	Students will complete a series of labs to explore the relationships between climate, oceans, and weather. They will evaluate both natural and anthropogenic impacts on the climate. They will examine	• web-sites/handouts providing background information on the properties of the atmosphere • materials for lab

	investigation of the properties of water and its effects on Earth materials and surface processes. CCSS.ELA-Literacy.RST.9-10.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. CCSS.ELA-Literacy.WHST.9-10.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.	how the oceans and ocean currents affect climate. They will induce how the influences from the ocean and climate changes are affecting weather systems. Students will then choose a major weather or climate event to research and report on.	activities
Unit 13: Earth Resources and Conserving Energy Number of 80-minute classes: 6	HS-PS3-1 Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. HS-ESS3-2. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.* HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.	Students will develop an understanding of how energy is obtained from both traditional resources (fossil fuels) and alternative resources. They will analyze and compare the impacts of obtaining and using these resources. Students will model how some these resources work in lab activities. They will also recognize where and why different resources are used in different locations around the world. They will create a graphic organizer that allows them to visually compare and display the benefits and costs of these resources.	• web-sites/handouts providing background information on energy resources • materials for lab activities • materials to create graphic organizer
Cumulative Semester Project: Modeling Energy Conversions	HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.* HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural,	Students will write short persuasive papers presenting their arguments for energy resources. Their papers must include a justification of how/why their resources are a better choice then others, citing appropriate evidence. They must also include specific information about impacts of their resources on climate and other environmental conditions (air quality, water quality, etc.) and how their energy source is	• appropriate technology to research and write papers

	and environmental impacts. CCSS.ELA-Literacy.RST.9-10.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. CCSS.ELA-Literacy.WHST.9-10.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.	converted from its original form into a usable form. Students will share summaries of their papers with the class.	

Habits Of Mind

NOTE: Habits of mind are labeled with the number of the unit in which they are applied.

All	Persisting – Sticking to it! Persevering in the task, through to completion; remaining focused. Looking for ways to reach your goal when stuck. Not giving up.	All	Thinking and Communicating with Clarity and Precision – Being clear! Striving for accurate communication in both written and oral form; avoiding over-generalizations, distortions, deletions and exaggerations.
All	Managing Impulsivity – Take your time! Thinking before acting; remaining calm, thoughtful and deliberate.	1,2, 3,4, 11, 12, 13	Gathering Data Through All Your Senses – Using your natural pathways! Paying attention to the world around you. Gathering data through all the senses; taste, touch, smell, hearing and sight.
All	Listening With Understanding and Empathy – Understanding others! Devoting mental energy to another person's thoughts and ideas. Making an effort to see another's point of view and emotions.	3,5, 6,7, 8, 10, 12, 13	Creating, Imagining, and Innovating – Trying a different way! Generating new ideas and novel ideas, developing original solutions, processes and products.
All	Thinking Flexibly – Looking at it another way! Being able to change perspectives, generate alternatives, consider options.	All	Responding With Wonderment and Awe – Having fun figuring it out! Finding the world to be awesome and mysterious; being intrigued with phenomena and with beauty.
All	Thinking About Your Thinking *(metacognition)* – Knowing your own thoughts! Being aware of your thoughts, strategies, feelings and actions – and their effects on others.	All	Taking Responsible Risks – Venturing out! Being adventurous; living on the edge of your understanding and competence. Constantly trying new things.
All	Striving For Accuracy – Checking it again! Always doing your best. Setting high	All	Finding Humor – Laughing a little! Finding the whimsical, incongruous, and unexpected.

	standards. Checking for and finding ways to constantly improve.		Being able to laugh at yourself.
All	Questioning and Posing Problems – Having a questioning attitude; knowing what data are needed and developing questioning strategies to produce those data. Finding problems to solve.	All	Thinking Interdependently – Working together! Being able to work with and learn from others, in reciprocal situations. Working as a team.
All	Applying Past Knowledge To New Situations – Using what you learn! Accessing prior knowledge; transferring knowledge beyond the situation in which it was learned.	All	Remaining Open to Continuous Learning – Believing you have so much more to learn! Having humility and self-acceptance when admitting we don't know something; resisting complacency. Considering the world beyond your comfort zone.

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