PROGRAM CONCENTRATION: **Government & Public Safety**
CAREER PATHWAY: **JROTC – Air Force**
COURSE TITLE: **28.01500 Aerospace Science: Space Exploration**

Air Force Junior ROTC Curriculum
The Georgia Performance Standards for the Air Force Junior ROTC curriculum are designed to provide students with the knowledge and skills necessary to "develop citizens of character dedicated to serving their community and nation." **McREL** Standards and Benchmarks were used for all AFJROTC courses except Astronomy, Survival, and Global and Cultural Studies. Supported by contracts with the U.S. Education Department, Office of Educational Research and Improvement, **McREL** is one of ten Regional Educational Laboratories at the forefront of research, practice, and evaluation related to standards-based education and it has been awarded standards-based classroom instruction as its national leadership area within the regional educational laboratory network. Global and Cultural Studies used the **National Council on Social Studies** (NCSS) correlation, a nationally recognized source for social studies standards. Astronomy and Survival were correlated to the Georgia Performance Standards. All AFJROTC courses were compared to the **Georgia Performance Standards** for Social Studies, Math, Language Arts, and Science, and specific correlations were listed following each AFJROTC standard where applicable. Technology is infused into all AFJROTC curriculum.

All McREL Standards and Benchmarks are available for AFJROTC instructors and authorized users at https://owa.afjrotc.net/cybercampus_prod/default.aspx in the Library under Curriculum, McRel Standards and Benchmarks. Additional national education standards are referenced in this copyrighted cyber campus information. Georgia AFJROTC instructors should reference both the Georgia and McREL standards to meet both AFJROTC and Georgia student education requirements.

Space Exploration content and process skills on the AFJROTC Cyber campus have been correlated with National Science Standards for Grades 9 – 12, National Association of Teachers of Mathematics Standards, Colorado State Science Standards for Grades 9 – 12 and Colorado Math Standards.

Course Description:
Aerospace Science: Space Exploration guides students through an all new world of satellites, orbits, space environments and travel to other planets. Students gain great insights into how and why we go to so much trouble to put complicated satellites into orbit. The discoveries and sacrifices of many space pioneers are highlighted in this course. Basic concepts of space flight, high school math, physics, and science are brought to life as students study space exploration.

PS-AFES-1. Students will know the advantages offered by space and its unique environment. Students will know the elements common to all space missions and how they work together for success

a. Explain unique characteristics of space.
b. Describe current missions.
c. Identify the elements that make up a space mission.
d. Illustrate how various mission elements work together.

Academic Standard(s):
SP6. The student will describe the corrections to Newtonian physics given by quantum mechanics and relativity when matter is very small, moving fast compared to the speed of light, or very large.

NSS E.2. All students should develop understandings about science and technology.

NSS F.6. All students should develop an understanding of science and technology in local, national, and global challenges

NSS G.1. All students should develop an understanding of science as a human endeavor.

PS-AFES-2. Students will know the rapid changes in space exploration in the 20th century from the first crude rockets to space shuttles. They will know scientific and commercial space achievements and key events in the creation of Air Force Space Command.

a. Identify major events that have led to our ability to explore space.
b. Describe current trends in the exploration of space.
c. Identify recent scientific and commercial achievements in space explorations.
d. Diagram key events in the creation of Air Force Space Command.

Academic Standard(s):
SP6 The student will describe the connections to Newtonian physics given by quantum mechanics and relativity when matter is very small, moving fast compared to the speed of light, or very large.

NSS D.1. Students should develop an understanding of the origin and evolution of the universe.

NSS E.2. Students should develop understandings about science and technology.
NSS 6.C. Students should develop an understanding of science and technology in local, national, and global challenges.

NSS G.1. Students should develop an understanding of science as a human endeavor.

NSS G.2. Students should develop an understanding of the nature of scientific knowledge.

NSS G.3. Students should develop an understanding of historical perspectives.

PS-AFES-3. Students will know where space is and Earth's place in the universe. Students will know the major hazards of the space environment and their effect on spacecraft and mankind

a. Explain where space begins and how it's defined based on its beginning.
b. Diagram Earth's place in the universe in relationship with major celestial objects.
c. Describe major hazards of the space environment including their effect on spacecraft.
d. Compare and contrast the three effects free-fall environments have on the human body.

e. Describe the major hazards of the space environment that pose a problem for humans living and working in space.

Academic Standard(s):
SPS3. Students will distinguish the characteristics and components of radioactivity.

S7. Students will relate transformations and flow of energy within a system.

NATM. Understand numbers, ways of representing numbers, relationships among numbers, and number systems.

NATM. Understand measurable attributes of objects and the units, systems, and processes of measurements.

NATM. Recognize and apply mathematics outside of mathematics.

NSS E.2. Students should develop understandings about science and technology.

NSS 6.C. Students should develop an understanding of science and technology in local, national, and global challenges.

PS-AFES-4. Students will know the definition of an orbit and how an object is put into orbit. Students will know the steps in the motion analysis process. Students will comprehend the concepts of weight, mass and inertia. Students will know and apply Newton's Laws of Motion.

a. Diagram and define an orbit.
b. Explain how an object is put into orbit from Earth.
c. Outline the steps in the motion analysis process.
d. Describe weight, mass and inertia.
e. Demonstrate Newton's laws of motion.

Academic Standard(s):
SP1. Students will analyze the relationships between force, mass, gravity, and the motion of objects.

PS5. Students will compare and contrast the phases of matter as they relate to atomic and molecular motion.

SPS7. Students will relate transformations and flow of energy within a system.

SPS8. Students will determine relationships among force, mass, and motion.

SC6. Students will understand the effects motion of atoms and molecules in chemical and physical processes.

SCSh5. Students will demonstrate the computation and estimation skills necessary for analyzing

data and developing reasonable scientific explanations.

SCSh8. Students will understand important features of the process of scientific inquiry.

NATM. Understand patterns, relationships, and functions.

NATM. Represent and analyze mathematical situations and structures using algebraic symbols.

NSS B.4. *Students should develop an understanding of motions and forces.*

NSS B.5. *Students should develop an understanding of conservation of energy.*

PS-AFES-5. Students will know why spacecraft ground tracks look the way they do and what is required to move them.

a. Explain ground tracks and how spacecraft ground tracks are used.
b. Diagram and describe why certain types of missions use certain types of orbits.
c. Illustrate the steps needed to move a satellite from one orbit to another

Academic Standard(s):
SP1. Students will analyze the relationships between force, mass, gravity, and the motion of objects.

PS5. Students will compare and contrast the phases of matter as they relate to atomic and molecular motion.

SPS8. Students will determine relationships among force, mass, and motion.

SC6. Students will understand the effects motion of atoms and molecules in chemical and physical processes.

SCSh5. Students will demonstrate the computation and estimation skills necessary for analyzing data and developing reasonable scientific explanations.

SCSh8. Students will understand important features of the process of scientific inquiry.

NATM. Understand numbers, ways of representing numbers, relationships among numbers, and number systems.

NATM. Recognize and apply mathematics outside of mathematics.

NSS B.4. Students should develop an understanding of motions and forces.

NSS B.5. Students should develop an understanding of conservation of energy.

NSS E.2. Students should develop understandings about science and technology...

PS-AFES-6. Students will know basic planning for a spacecraft's transfer from one planet to another after they escape Earth's gravitational pull.

a. Describe the steps needed for a spacecraft to travel from one planet to another.
b. Explain gravity-assist trajectories and how they can help spacecraft travel between the planets.

Academic Standard(s):
SP1. Students will analyze the relationships between force, mass, gravity, and the motion of objects.

SPS8. Students will determine relationships among force, mass, and motion.

SC6. Students will understand the effects motion of atoms and molecules in chemical and physical processes.

SCSh5. Students will demonstrate the computation and estimation skills necessary for analyzing data and developing reasonable scientific explanations.

SCSh8. Students will understand important features of the process of scientific inquiry.

NSS B.4. *Students should develop an understanding of motions and forces.*

PS-AFES-7. Students will comprehend the history and purpose of ICBM's. Students will comprehend the Anti-Ballistic Missile Treaty. Students will know launch windows and how they constrain when we can launch into a particular orbit.

a. Define a ballistic trajectory.
b. Diagram six initial conditions of a ballistic trajectory.
c. Explain the purpose of Intercontinental Ballistic Missiles (ICBM's).
d. Identify key historical points in the development of ICBM's.
e. Describe the Anti-Ballistic Missile Treaty.
f. Define a launch window.
g. Determine time using Earth's rotation.
h. Compare and contrast sidereal time and solar time.

Academic Standard(s):
SSUSH20. The student will analyze the domestic and international impact of the Cold War on the United States.

SP1. Students will analyze the relationships between force, mass, gravity, and the motion of objects.

SCSh7. Students will analyze how scientific knowledge is developed.
SP6. The student will describe the corrections to Newtonian physics given by quantum mechanics and relativity when matter is very small, moving fast compared to the speed of light, or very large.

SES1. Students will investigate the composition and formation of Earth systems, including the Earth's relationship to the solar system.

MA2G4. Students will recognize, analyze, and graph the equations of the conic sections (parabolas, circles, ellipses, and hyperbolas).

MM3G2. Students will recognize, analyze, and graph the equations of the conic sections (parabolas, circles, ellipses, and hyperbolas).

NATM. Represent and analyze mathematical situations and structures using algebraic symbols.

NATM. Recognize and apply mathematics outside of mathematics.

NSS A.2. All students should develop understandings about scientific inquiry.

NSS B.4. Students should develop an understanding of motions and forces.

NSS E.2. Students should develop understandings about science and technology...

NSS F.6. All students should develop an understanding of science and technology in local, national, and global challenges.

NSS G.3. All students should develop an understanding of historical perspectives.

PS-AFES-8. Students will know the competing requirement of re-entry design. Students will know a re-entry corridor and its importance. Students will apply the motion analysis process (MAP) checklist to re-entry motion and discuss the results.

a. Identify the factors to consider in planning for spacecraft to re-enter Earth's atmosphere.
b. Define a re-entry corridor.
c. Explain how to apply the motion analysis process (MAP) checklist to re-entry motion.

Academic Standard(s):

SES1. Students will investigate the composition and formation of Earth systems, including the Earth's relationship to the solar system.

SES6. Students will explain how life on Earth responds to and shapes Earth systems.

SP6. The student will describe the corrections to Newtonian physics given by quantum mechanics and relativity when matter is very small, moving fast compared to the speed of light, or very large.

MA2G5. Students will investigate planes and spheres.

NATM. Understand patterns, relationships and functions.

NATM. Recognize and apply mathematics outside of mathematics.

NSS A.2. All students should develop understandings about scientific inquiry.

NSS. B.5. All students should develop an understanding of conservation of energy and increase in disorder.

PS-ASES-9. Students will know the systems-engineering process and how it is applied to designing space missions, spacecraft, and a spacecraft's major subsystems.

a. Describe the systems engineering process and how it is used in designing space missions.
b. Define payload and explain how payload requirements affect spacecraft design.
c. Diagram the major spacecraft subsystems.
d. Label and explain the elements of a remote-sensing system.

Academic Standard(s):
MA1G5. . Students will find and compare the measures of spheres.

MM1A2. Students will simplify and operate with radical expressions, polynomials, and rational expressions.

NSS. B.4. All students should develop an understanding of motion and forces.

NSS. E.1. All students should develop abilities of technological design.

NSS. E.2. All students should develop understandings about science and technology.

PS-AFES-10. Students will know the elements of a space-vehicle control system, including open-loop and closed-loop control systems, and know the steps in the control process.

a. Illustrate the elements of a space-vehicle control system.
b. Compare and contrast open-loop and closed-loop control systems.
c. Outline the steps in the control process.
d. Describe the functions of control systems.

Academic Standard(s):
SCSh1. Students will evaluate the importance of curiosity, honesty, openness, and skepticism in science.

SCSh8. Students will understand important features of the process of scientific inquiry.

NSS. E.1. All students should develop abilities of technological design.

NSS. E.2. All students should develop understandings about science and technology.

PS-AFES-11. Students will know the main function of the environment control and life-support subsystems (ECLSS), the main sources of heat for a spacecraft, and how to apply systems engineering to designing and testing the ECLSS.

a. Compare and contrast the two main tasks of a spacecraft's environmental control and life-support subsystem.
b. Identify the main sources of heat for a spacecraft.
c. Diagram how to use the three basic means of heat transfer - conduction, convection, and radiation - and how to use them on a spacecraft.
d. Describe different ways to control heat outside and inside a spacecraft.
e. Explain how, from a standpoint of the life support, humans are viewed as systems with inputs and outputs.

Academic Standard(s):

SCSh1. Students will evaluate the importance of curiosity, honesty, openness, and skepticism in science.

SCSh8. Students will understand important features of the process of scientific inquiry.

SC5. Students will understand that the rate at which a chemical reaction occurs can be affected by changing concentration, temperature, or pressure and the addition of a catalyst.

SC6. Students will understand the effects motion of atoms and molecules in chemical and physical processes.

SP2. Students will evaluate the significance of energy in understanding the structure of matter and the universe.

MA2D4. Students will understand the differences between experimental and observational studies by posing questions and collecting, analyzing, and interpreting data.

MA1D5. Students will determine an algebraic model to quantify the association between two quantitative variables.

MA1P4. Students will make connections among mathematical ideas and to other disciplines.

MA2P4. Students will make connections among mathematical ideas and to other disciplines.

NATM. Understand numbers, ways of representing numbers, relationships among numbers, and number systems.

NATM. Represent and analyze mathematical situations and structures using algebraic symbols.

NATM. Recognize and apply mathematics outside of mathematics.

NSS. B.2. All students should develop an understanding of the structure and properties of matter.

NSS. B.5. All students should develop an understanding of conservation of energy and increase in disorder.

NSS. E.2. All students should develop understandings about science and technology.

NSS. G.3. All students should develop an understanding of historical perspectives.

PS-AFES-12. Students will know the basic operating principles of rockets from a systems perspective.

a. Explain how rockets work.
b. Define important parameters to describe rocket performance -thrust, specific impulse, and velocity change.
c. Illustrate how rockets convert stored energy into thrust.
d. Diagram the key elements of propulsion subsystems.
e. Explain the basic operating principles for the different types of rockets in use.
f. Compare and contrast the advantages and disadvantages of different types of rockets.
g. Describe the subsystems that make up a launch vehicle.
h. Define staging and explain the advantages and disadvantages of using staging for launch vehicles.

Academic Standard(s):

SCSh1. Students will evaluate the importance of curiosity, honesty, openness, and skepticism in science.

SCSh8. Students will understand important features of the process of scientific inquiry.

SC5. Students will understand that the rate at which a chemical reaction occurs can be affected by changing concentration, temperature, or pressure and the addition of a catalyst.

SC6. Students will understand the effects motion of atoms and molecules in chemical and physical processes.

SP2. Students will evaluate the significance of energy in understanding the structure of matter and the universe.

MA2D4. Students will understand the differences between experimental and observational studies by posing questions and collecting, analyzing, and interpreting data.

MA1D5. Students will determine an algebraic model to quantify the association between two quantitative variables.

MA1P4. Students will make connections among mathematical ideas and to other disciplines.

NATM. Understand numbers, ways of representing numbers, relationships among numbers, and number systems.

NATM. Understand patterns, relationships, and functions.

NATM. Represent and analyze mathematical situations and structures using algebraic symbols.

NATM. Recognize and apply mathematics outside of mathematics.

NSS. B.1. All students should develop understandings about structure of atoms.

NSS. B.3. All students should develop an understanding of chemical reactions.

NSS. B. 4. All students should develop an understanding of motion and forces.

NSS. B.6. All students should develop an understanding of interactions of energy and matter.

NSS. E.2. All students should develop understandings about science and technology.

NSS. G.1. All students should develop an understanding of science as a human endeavor.

NSS. G.3. All students should develop an understanding of historical perspectives.

PS-AFES-13. Students will know the elements of the mission operations systems including communications, operations, management, and teamwork.

a. Identify mission operations systems.
b. Diagram the four operations systems that help get a launch vehicle and payload into space.
c. Illustrate the four elements of communication architecture that are important to communication between satellites and ground stations.
d. Describe the components of NASA's and DOD's major satellite-control networks.
e. Compare and contrast the roles of mission management and operations teams during the each mission phase.
f. List basic principles of team management.
g. Identify and explain some useful management tools.
h. Explain the advantages of spacecraft autonomy.

Academic Standard(s):

SCSh1. Students will evaluate the importance of curiosity, honesty, openness, and skepticism in science.

SCSh8. Students will understand important features of the process of scientific inquiry.
SP2. Students will evaluate the significance of energy in understanding the structure of matter and the universe.

MA2D4. Students will understand the differences between experimental and observational studies by posing questions and collecting, analyzing, and interpreting data.

MA1D5. Students will determine an algebraic model to quantify the association between two quantitative variables.

MA1P4. Students will make connections among mathematical ideas and to other disciplines.

NATM. Understand numbers, ways of representing numbers, relationships among numbers, and number systems.

NATM. Understand patterns, relationships, and functions.

NSS. A.2. All students should develop understandings about scientific inquiry.

NSS. B.4. All students should develop an understanding of motion and forces.

NSS. B.6. All students should develop an understanding of interactions of energy and matter.

NSS. E.2. All students should develop understandings about science and technology.

NSS. G.1. All students should develop an understanding of science as a human endeavor.

NSS. G.3. All students should develop an understanding of historical perspectives.

PS-AFES-14. Students will know emerging trends in the space industry based on markets, politics, and international law.

a. Describe emerging trends in the space industry.
b. Identify markets for commercial space activities, giving specific examples of each.
c. List political reasons for exploring space.
d. Explain seven key principles of international space law.
e. Describe the functions of the International Telecommunications Union.
f. Explain how national policies affect space missions.
g. Identify factors that contribute to the cost of a space mission.
h. Explain the importance of estimating costs when planning missions and the concept of internal rate of return.
i. Describe how the concept of internal rate of return affects investment in commercial space missions.

Academic Standard(s):

SCSh1. Students will evaluate the importance of curiosity, honesty, openness, and skepticism in science.

SCSh8. Students will understand important features of the process of scientific inquiry.

SSUSH20. The student will analyze the domestic and international impact of the Cold War on the United States.

SSUSH25. The student will describe changes in national politics since 1968.

MA2D4. Students will understand the differences between experimental and observational studies by posing questions and collecting, analyzing, and interpreting data.

NATM. Understand numbers, ways of representing numbers, relationships among numbers, and number systems.

NATM. Understand measurable attributes of objects and the units, systems, and processes of measurements.

NATM. Recognize and apply mathematics outside of mathematics.

NSS. A.2. All students should develop understandings about scientific inquiry.

NSS. E.2. All students should develop understandings about science and technology.

NSS. F.6. All students should develop understandings about science and technology in local, national, and global challenges

NSS. G.1. All students should develop an understanding of science as a human endeavor.

PS-AFES-15. Students will identify US and Soviet manned space flights, the purpose of their missions, and they lessons learned during their space operations.

A. Create a timeline of the U.S. manned space flights and the purpose of their missions.
b. Create a timeline of the Soviet manned space flights and their mission purposes.
c. Describe the main elements of the Space Shuttle system starting with the early development and ending with the current program.
d. Explain how Shuttle operations work at NASA's Johnson Space Center.
e. Identify important concepts in the history of space stations.
f. Compare and contrast Europe's Spacelab with the International Space Station. Make mission and physical comparisons.
g. Describe scientific research that takes place onboard the International Space Station.
h. Explain living and working conditions in space.
I. Identify benefits of having future colonies in space.

Academic Standard(s):

SCSh1. Students will evaluate the importance of curiosity, honesty, openness, and skepticism in science.

SCSh8. Students will understand important features of the process of scientific inquiry.

SSUSH20. The student will analyze the domestic and international impact of the Cold War on the United States.

SSUSH25. The student will describe changes in national politics since 1968.

NSS. E.2. All students should develop understandings about science and technology.

NSS. G.1. All students should develop an understanding of science as a human endeavor.

NSS. G.3. All students should develop an understanding of science as a human endeavor.

Reading Across the Curriculum

Reading Standard Comment

After the elementary years, students engage in reading for learning. This process sweeps across all disciplinary domains, extending even to the area of personal learning. Students encounter a variety of informational as well as fictional texts, and they experience text in all genres and modes of discourse. In the study of various disciplines of learning (language arts, mathematics, science, social studies), students must learn through reading the communities of discourse of each of those disciplines. Each subject has its own specific vocabulary, and for students to excel in all subjects, they must learn the specific vocabulary of those subject areas in context.

Beginning with middle grades years, students begin to self-select reading materials based on personal interest established through classroom learning. Students become curious about science, mathematics, history, and literature as they form contexts for those subjects related to their personal and classroom experiences. As students explore academic areas through reading, they develop favorite subjects and become confident in their verbal discourse about those subjects.

Reading across curriculum content develops both academic and personal interests in students. As students read, they develop both content and contextual vocabulary. They also build good habits for reading, research, and learning. The Reading Across the Curriculum standard focuses on the academic and personal skills students acquire as they read in all areas of learning.

Students will enhance reading in all curriculum areas by:

a. Reading in all curriculum areas
    - Read a minimum of 25 grade-level appropriate books per year from a variety of subject disciplines and participate in discussions related to curricular learning in all areas.
    - Read both informational and fictional texts in a variety of genres and modes of discourse.
    - Read technical texts related to various subject areas.
b. Discussing books
    - Discuss messages and themes from nooks in all subject area.
    - Respond to a variety of texts in multiple modes of discourse.
    - Relate messages and themes from one subject area to messages and themes in another area.
    - Evaluate the merit of texts in every subject discipline.
    - Examine author’s purpose in writing.
    - Recognize the features of disciplinary texts.
c. Building vocabulary knowledge
    - Demonstrate an understanding of contextual vocabulary in various subjects.
    - Use content vocabulary in writing and speaking.

- Explore understanding of new words found in subject area texts.

d. Establishing content
    - Explore life experiences related to subject area content.
    - Discuss in both writing and speaking how certain words are subject area related.
    - Determine strategies for finding content and contextual meaning for unknown words.

CTAE Foundation Skills

The Foundation Skills for Career, Technical and Agricultural Education (CTAE) are critical competencies that student pursuing any career pathway should exhibit to be successful. As core standards for all career pathways in all program concentrations, these skills link career, technical and agricultural education to the state's academic performance standards.

The CTAE Foundation Skills are aligned to the foundation of the U. S. Department of Education's 16 Career Clusters. Endorsed by the National Career Technical Career Technical Education Consortium (NASDCTEc), the foundation skills were developed from an analysis of all pathways in the sixteen occupational areas. These standards were identified and validated by a national advisory group of employers, secondary and post-secondary educators, labor associations, and other stakeholders. The Knowledge and Skills provide learners a broad foundation for managing lifelong learning and career transitions in a rapidly changing economy.

CTAE-FS-1 Technical Skills: Learners achieve technical content skills necessary to pursue the full range of career for all pathways in the program concentration

CTAE-FS-2 Academic Foundations: Learners achieve state academic standards at or above grade level.

CTAE-FS-3 Communications: Learners use various communication skills in expressing and interpreting information.

CTAE-FS-4 Problem Solving and Critical Thinking: Learners define and solve problems, and use problem-solving and improvement methods and tools.

CTAE-FS-5 Information Technology Applications: Learners use multiple information technology devices to access, organize, process, transmit, and communicate information.

CTAE-FS-6 Systems: Learners understand a variety of organizational structures and functions.

CTAE-FS-7 Safety, Health and Environment: Learners employ safety, health and environmental management systems in corporations and comprehend their importance to organizational performance and regulatory compliance.

CTAE-FS-8 Leadership and Teamwork: Learners apply leadership and teamwork

skills in collaborating with others to accomplish organizational goals and objectives.

CTAE-FS-9 Ethics and Legal Responsibilities: Learners commit to work ethics, behavior, and legal responsibilities in the workplace.

CTAE-FS-10 Career Development: Learners plan and manage academic-career plans and employment relations.

CTAE-FS-11 Entrepreneurship: Learners demonstrate understanding of concepts, processes, and behaviors associated with successful entrepreneurial performance.