Mississippi Secondary Career and Technical Education
2018 Unmanned Aerial Systems DRAFT
4.0 Credits (recommended)

Important Note: In order for any Mississippi school district to initiate this program and use this curriculum, they must first contact Dr. Aimee Brown at the MDE for pre-approval, then verify all mandatory items listed in the *MS CTE UAS Initiation Guide* (separate file in the project Google folder).

Pathway Description

Unmanned Aerial Systems (UAS) is intended to be an exclusive, secondary CTE pathway in the STEM cluster for students interested in pursuing careers in the burgeoning UAS field. Skills stemming from this pathway include electronics, avionics, aerospace science, GIS, airspace regulations/law, maintenance, mission planning, and flight control (manual and autonomous). At this point, the curriculum will align with Hinds Community College's UAS program, but as other postsecondary institutions add this pathway, we will work to achieve universal alignment. Skills acquired in this course will be applicable in many industry sectors to include: military, agriculture, engineering, law enforcement, emergency management, forestry, real estate, marketing, and transportation.

UAS Task Force Team Members

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Maximum Capacity of a single UAS section (year one and two) is 12 students for safety and one-on-one time with instructor.

Course Outlines

Option 1 – Four One-Carnegie-Unit Courses
This curriculum consists of four one-credit courses, which should be completed in the following sequence:

1. **Introduction to Unmanned Aircraft Systems—Course Code:**
2. **UAS Flight and Engineering Design—Course Code:**
3. **Building a Universal Flight Platform—Course Code:**
4. **Fitting UAS for specific Applications and Careers—Course Code:**

Course Description:

Introduction to Unmanned Aircraft Systems—Course Code:

Unit Number	Unit Name	Hours
1	Introduction to Unmanned Aircraft Systems	15
2	UAS Safety Regulations and Operational Policies	10
3	UAS Flight Simulation	50
4	Career Pathway Exploration	55
5	Leadership Development and Student Organization	10
Total		140

UAS Flight and Engineering Design—Course Code:

Unit Number	Unit Name	Hours
6	Introduction to FAA Part 107	10
7	Flight Theory	30
8	UAS Components, Construction and Flight	60
9	Advanced Leadership Development	40
Total		140

Building a Universal Flight Platform—Course Code:

Unit Number	Unit Name	Hours
10	Career Applications	15
11	FAA Part 107 Integration	10
12	Introduction to Autonomous UAS	30
13	Building an Autonomous Quadcopter UAS	60
14	Advanced Flight Skills	25
Total		140

Fitting UAS for specific Applications and Careers—Course Code:

Unit Number	Unit Name	Hours
15	Data Processing Systems	50
16	Sensors on UAS	50
17	UAS Capstone Project	40
Total		140

Option 2 – Two (2) Two-Carnegie-Unit Courses

This curriculum consists of two (2) two-credit courses, which should be completed in the following sequence:

1. UAS Technology I
2. UAS Technology II
Course Description: II

UAS Technology I—Course Code:

Unit Number	Unit Name	Hours
1	Introduction to Unmanned Aircraft Systems	15
2	UAS Safety Regulations and Operational Policies	10
3	UAS Flight Simulation	50
4	Career Pathway Exploration	55
5	Leadership Development and Student Organization	10
6	Introduction to FAA Part 107	10
7	Flight Theory	30
8	UAS Components, Construction and Flight	60
9	Advanced Leadership Development	40
Total		280

UAS Technology II—Course Code:

Building a Universal Flight Platform—Course Code:

Unit Number	Unit Name	Hours
10	Career Applications	15

11	FAA Part 107 Integration	10
12	Introduction to Autonomous UAS	30
13	Building an Autonomous Quadcopter UAS	60
14	Advanced Flight Skills	25
15	Data Processing Systems	50
16	Sensors on UAS	50
17	UAS Capstone Project	40
Total		140

Year 1

Unit 1: Introduction to Unmanned Aircraft Systems

Competencies and Suggested Objectives
1. Explore the history, development, and future of unmanned aircraft. a. Define terms associated with unmanned aircraft systems and operation. ● UAS ● Drone ● NAS ● Manned aircraft ● Airspace ● Unmanned aircraft ● Aviation ● Aircraft ● Recreational use ● Commercial use ● Hobby ● Civil twilight ● Waiver ● Aeronautical ● FAA Part 107 ● SRMA Section 336 ● Airspace restrictions ● No Drone Zone ● sUAS ● VTOL ● Hover ● Fixed-wing aircraft ● Rotary wing aircraft ● Multi-rotor aircraft b. Understand evolution of Unmanned Aircraft Systems. c. Discuss the current state of the UAS industry. d. Research possibilities for future developments in the UAS industry.
2. Compare and contrast the common configurations of rotary and fixed wing unmanned aircraft. a. Identify common rotary aircraft configurations to include: single rotor, tri-rotor, quad-rotor, hex-rotor, and eight rotor aircraft. b. Explain the purpose of each of the types of rotary aircraft configurations. c. Identify fixed-wing aircraft configurations. d. Explain the purpose of fixed-wing aircraft.

e. Discuss applications and describe possible missions for both rotary and fixed wing aircraft.

Unit 2: UAS Safety Regulations and Operational Policies

Competencies and Suggested Objectives

1. Explain FAA rules and regulations for UAS operations.
   a. Describe the major weight classifications of unmanned aircraft as defined by the FAA.
      - Group 1
      - Group 2
   b. Explain how UAS are treated as aircraft by the FAA/state authorities.

2. Demonstrate an understanding of safety guidelines and operational rules related to UAS operation and use.
   a. Using Federal Aviation Administration guidelines, define the types of UAS aircraft. (Governmental, civil operations, model aircraft)
   b. Explain safety guidelines regarding the operation and use for each type of UAS aircraft.
   c. Describe basic safety regarding the use of batteries in a UAS.
   d. Describe the effects of the weather on safe UAS operation.
   e. Discuss the risks of flying a UAS.
   f. Relate ethical flight operation to safely operating a UAS.

3. Describe community standards for recreational and hobby aircraft used in education as set by the Academy of Model Aeronautics (AMA).
   a. Explain why there are community standards.
   b. Compare the differences between a community standard and a regulation or law.
   c. Review the AMA guidelines for operating model aircraft and complete the AMA online sUAS Information and Safety course.

4. Explain the concept of airspace and how it defines where an UAS can be flown.
   a. Identify altitude, speed, and weather restrictions as described in FFA Part 107 guidelines.
   b. Identify and describe the types of airspace where UAS operation is prohibited
      - Class B/C/D large towered airports
      - Within 5 miles of other airports & heliports
      - Temporary Flight Restrictions (TFRs) including sporting events
      - Restricted and Prohibited Areas
      - Other areas by Notice to Airmen (NOTAM)
   c. Investigate a national UAS flight plan using the *B4UFly* application on smart phones.

Unit 3: UAS Flight Simulation

Competencies and Suggested Objectives
1. Demonstrate proficiency in operating equipment used in UAS flight. a. Define terms associated with flight simulation. ● Flight controller ● Display ● Environmental functions ● Aircraft selection ● Modification b. Operate a flight simulation program from start through flight to restart.
2. Compare UAS aircraft types by initial simulated flight experience. - Fixed-wing, multirotor, helicopter. a. Complete a fixed-wing flight simulation and describe the experience. b. Complete a multi-rotor flight simulation and describe the experience. c. Complete a helicopter flight simulation and describe the experience. d. Relate aircraft flight characteristics to where each can be used.
3. Recall safety guidelines for the operations of the various types of UAS. a. Differentiate between the consequences of unsafe actions in simulation flight versus actions in real flight.
4. Describe functions of aircraft control and how they are used to fly: a. Identify the throttle and its function in flight. b. Identify the rudder and its function in flight. c. Identify the elevator and its function in flight. d. Identify the aileron and its function in flight.
5. Demonstrate safe, consistent flight in one aircraft type - simulation practical test. a. Fly a representative fixed wing from takeoff to fly around and land. b. Fly a representative multi-rotor helicopter from takeoff to fly around and land. c. Fly a representative single rotor helicopter from takeoff to fly around and land.

Unit 4: Career Pathway Exploration

Competencies and Suggested Objectives
1. Investigate how UAS and remote sensing technology is being used in various industries. a. Research careers that utilize UAS and remote sensing. b. Design a presentation that illustrates how UAS incorporate remote sensing to collect data. c. Identify areas of research or innovations that might use UAS and remote sensing to improve a product or service.
2. Investigate how UAS and package delivery technology are being used in various industries. a. Research careers that utilize UAS and package delivery. b. Design a presentation that illustrates how UAS incorporates package delivery c. Identify areas of research or innovations that might use UAS and package delivery to improve a product or service.
3. Investigate how UAS and communication technology are being used in various industries. a. Research careers that utilize UAS and communication. b. Design a presentation that illustrates how UAS incorporates communication technology. c. Identify areas of research or innovations that might use UAS and communications to improve a product or service.
4. Investigate the use and application of UAS technology in various industries. a. Describe how the military uses UAS technology. b. Describe how UAS are used in agriculture. c. Describe how UAS are used in the construction industry. d. Describe how UAS technology is used in law and public safety. e. Describe how UAS technology is used by commercial businesses. f. Describe how UAS technology is used by natural resources and conservation entities. g. Describe other ways UAS technology is being used.

Unit 5: Leadership Development and Student Organizations

Competencies and Suggested Objectives

1. Explore opportunities provided by student organizations a. Identify leadership and personal development skills. b. Identify and practice effective communication concerning verbal, non-verbal, writing and technology skills. c. Work as a team to design a community service project for which the knowledge and skills learned in the course can be used to improve the lives of others.
2. Demonstrate effective communications skills in career development. a. Describe the importance of effective communication skills. b. Demonstrate verbal and nonverbal communication skills. c. Apply appropriate speaking and listening skills to class and work related situations.
3. Demonstrate leadership skills in class and work related situations a. Define leadership. b. Discuss the attributes of a leader. c. Identify the roles a leader.
4. Utilize team building skills in class and work related situations. a. Define team building. b. Discuss the attributes of teamwork. c. Demonstrate teamwork skills to complete an assigned task.
5. Discuss the benefits of participating in a program area student organization related to UAS technology. a. Explore various student organization competitions. b. Describe competition skills or tasks needed to successfully prepare for a competition. c. Participate in a student organization competition. d. Perform the tasks required to complete an assigned requirement for a student competition.
6. Establish and/or charter AMA Club membership and participate in club programming and educational programs.

Unit 6: Introduction to FAA Part 107

Competencies and Suggested Objectives

1. Discuss the purpose of the Federal Aviation Administration's Part 107.
   a. Describe a remote pilot-in-command.
   b. Explain why FAA is the waiver authority for Part 107.

2. Explain the operating rules for small unmanned aircraft.
   a. Define terms associated with the operation of small unmanned aircraft.
      - Knots
      - Nighttime flight
      - Civil twilight
      - Line-of-sight
      - Hazardous material
      - Carriage
      - Airspace
      - Prohibitions
      - Class B airspace
      - Class C airspace
      - Class D airspace
      - Class E airspace
      - Airport authority
      - Nautical mile
      - Air traffic
      - Air traffic control
      - Airport control tower
      - Preflight inspection
      - Civil aircraft
      - Commercial aircraft

   b. Describe the operating limits for small unmanned aircraft.
      - <400 feet, 87 knots/100mph

   c. List prohibitions for operating small unmanned aircraft.
      - Operation from a moving vehicle or aircraft
      - Alcohol or drugs IAW FAR Part 91.17
      - Nighttime flight/civil twilight
      - Beyond line-of-sight
      - Multiple small UAS
      - Carriage of hazardous material
      - Operation near aircraft and over human beings

   d. Discuss the rules for operating unmanned aircraft in the vicinity of an airport.
      - Prohibited in flying in Class B/C/D/E airspace
      - Within 5 nautical miles of an airport
      - Advisement of airport authority/tower of intent to operate
      - Do not operate in any manner that is hazardous to air traffic at any airport

   e. Explain the importance of a preflight inspection prior to operating an unmanned aircraft.

f. Describe weather and cloud clearance requirements for flight.
g. Describe any other hazardous operations as they apply to unmanned flight (FAR §107.23).
h. Explain the need for remote pilot certification.
- Who should obtain Part 107 Certification
- Responsibilities of the Part 107 certificate holder

Unit 7: Flight Theory

Competencies and Suggested Objectives

1. Develop an understanding of the concepts involved in aerodynamics, flight control and aircraft propulsion.[DOK2]
   a. Define terms associated with flight theory.
      - Aerodynamics
      - Propulsion
      - Bernoulli effect
      - Lift
      - Weight
      - Thrust
      - Drag
      - Flight Stability
      - Center of Gravity
      - Throttle
      - Roll
      - Pitch
      - Yaw
      - Pitch
      - Airspeed
      - altitude

   b. Describe principles of aerodynamics and flight control. [DOK 2]
      - Bernoulli effect
      - Aerodynamic forces (e.g. lift, weight, thrust, drag and their effects on flight)

   c. Cite examples and provide diagrams to explain how the location center of gravity and other force centers affect flight stability.

2. Explain the influences on the four forces of flight.
   a. Describe how wing type and design influence lift.
   b. Demonstrate how the weight of the UAV affects the time it can remain airborne.
   c. Describe how the stability and safety of the UAV is affected by thrust.
   d. Demonstrate how the drag of the UAV affects operation during flight.

3. Demonstrate the use of flight controls to maintain aircraft stability and flight operation.
   a. Understand the four main control channels.
      - Throttle
      - Roll
      - Pitch
      - Yaw

   b. Understand directional movement relative to surfaces (Mode 2)
      - Move right toggle right = roll right
      - Move right toggle left = roll left
      - Move right toggle up = pitch forward
      - Move right toggle down = pitch backward

   c. Describe the limitations of airframe and performance.

● Airspeed ● Altitude ● Power system limitations ● Maximum weight d. Discuss the compatibility of power systems used in UAS flight.
4. Apply concepts of the four forces of flight using computer simulation programs to learn how to fly a UAV.

Unit 8: UAS Components, Construction and Flight

Competencies and Suggested Objectives
1. Demonstrate the safe use of tools needed to construct a Nano quad. a. Identify the proper tools needed for Nano quad UAS construction. ● scissors ● knives ● saws ● drills b. Demonstrate the safe use of tools used in Nano quad UAS construction.
2. Discuss basic flight theory and physical science as it applies to Nano quad UAS operation. a. Describe aircraft dynamic loading b. Estimate performance requirements based upon aircraft loading. c. Calculate motor and electrical system requirements to include battery and propeller selection.
3. Build a Nano Quadcopter UAS that weighs no more than 60 grams. a. Develop a research plan to design and build a Nano UAV. b. Select the appropriate frame and components to include propellers, motor, flight controllers and an FPV camera system. c. Using the principles of the scientific method, build and test the operation of the UAV and flight controller. ● Install the selected flight controller ● Program the flight controller (Windows based) ● Program the flight controller and flight tune the quadcopter ● Integrate, connect and test FPV system including monitor and goggles. ● Check the power system, battery and charger systems d. Practice safety and ethics while completing a preflight and systems check, flight test, tuning, troubleshooting and operation of the UAV.

Unit 9: Advanced Leadership Skill Development

Competencies and Suggested Objectives
1. Complete an assigned requirement for a student competition according to state-level rules.
2. Create and present a portfolio of the student UAS build. a. Write a technical description of the student UAS build project. b. Create a presentation to demonstrate the UAS build project. c. Design a resume and participate in a mock job interview. d. Analyze and reflect on the experience of building a UAS.

Year 2

Unit 10: Career Applications

NOTE: The following health foundations are for teaching and reinforcement and will be embedded objectives throughout the entire course as the instructor deems applicable.

Competencies and Suggested Objectives
1. Recognize the potential dangers of working with UAS in various careers and how to avoid them. a. Discuss the importance of identifying measures to maintain good health and safe working conditions. b. Evaluate task requirements for proper occupational safety and health needs.
2. Understand the ethical, cultural, and societal issues that may occur in the workplace. a. Identify forces that shape personality development and learning styles including personality traits, heredity, and environment. b. Research employment opportunities through various outlets like the WIN Job Center, Monster.com, MississippiWorks.org, etc. c. Use the Curriculum Career Pathway Map as a guide to research potential earnings, employee benefits, working conditions, and educational requirements. d. Describe basic employee responsibilities and appropriate work ethics of those working in the UAS industry.
3. Demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations. DOK 2, PK1.1.2 a. Follow basic written and verbal instructions. b. Effectively communicate in on-the-job situations.
4. Discuss personality roles in on-the-job situations. a. Explore personality development and the classroom environment in relation to teamwork skills and communication skills. b. Research personality/behavior assessment tools and explore how personality traits affect teamwork and leadership skills. (Myers-Briggs, Colors, DISC, etc.)

5. Prepare effective career documents. DOK2, PS2.4,PS2.6 a. Practice completing effective job applications. b. Develop an effective cover letter for a job application. c. Develop a functional and effective professional résumé.
6. Demonstrate proper interviewing techniques. DOK2, PS2.4,PS2.6 a. Identify acceptable professional attire for interviewing. b. Practice professional interviewing techniques. c. Participate in a mock interview.
7. Interact with professionals in careers using UAS Technology. DOK2, PS2.4,PS2.6 a. Observe or shadow a UAS pilot. b. Participate in workplace activities as the law allows. c. Participate in community service hours.

Unit 11: FAA Part 107 Integration

Competencies and Suggested Objectives
1. Determine how to register UAS aircraft according to FAA regulations. a. Distinguish among classes of UAS. ● Nano ● Micro ● Small ● Larger than 55 lb. b. Access the FAA registration website. c. Demonstrate the process to register or re-register UAS aircraft.
2. Describe the process that a UAS pilot must follow to become certified according to FAA Part 107. a. Compare and contrast a recreational/hobby UAS versus a commercial/educational UAS. b. Discuss how and when to take the FAA Part 107 certification exam. c. Optional: Take the FAA Part 107 practice exam or certification exam.
3. Explain the roles and responsibilities of crew positions during a flight. a. Describe remote pilot-in-command roles and responsibilities. b. Describe visual observer roles and responsibilities.
4. Demonstrate proficiency at evaluating airspace of the practice area. a. Identify a local airspace features and proximity to airports/heliports using the B4UFly application. b. Contact required outside agencies prior to flight. (Airport operator, control tower, etc.)
5. Demonstrate compliance and understanding of FAA flight regulations. a. During flight, demonstrate appropriate safety measures. b. In preparing for flight, demonstrate proper pre-flight procedures. c. Demonstrate an understanding of emergencies procedures during flight d. Explain drug and alcohol restrictions for a pilot and flight crew. e. Review restrictions on hazardous operation and operation of UAS from a moving vehicle. f. Review line of site requirements.

Unit 12: Introduction to Autonomous UAS

Competencies and Suggested Objectives
1. Program flight controllers to successfully complete a flight mission. a. PID tuning b. Calibrate sensors for GPS, the compass and accelerometers. c. Calibrate location and altitude sensing systems for GPS and MEMS.
2. Demonstrate the use of ground station systems. a. Operate computer based systems. b. Operate tablet based (android) systems
3. Incorporate mission control computer software and systems into UAS flight mission. a. Manage the functionality of the sensors. b. Design a mission plan to include mission control software.

Unit 13: Building an Autonomous Quadcopter UAS

Competencies and Suggested Objectives
1. Review how to safely use tools and equipment to build a quadcopter. a. Review how to safely use hand tools when constructing a quadcopter. b. Review how to safely use power tools when constructing a quadcopter. c. Discuss safety guidelines for using electrical tools in constructing a quadcopter.
2. Design and build a mission-capable quadcopter UAS. (<6 lbs., ready to fly (RTF) with plastic props only) a. Assemble components into complete quadcopter ready for flight controller. b. Configure power system for the required battery voltage. c. Make connections to aircraft motor system. d. Install flight controller. e. Program flight controller for power system and vehicle type. f. Run a preflight and systems check. g. Complete a flight test, which will include tuning and troubleshooting the aircraft.

Unit 14: Advanced Flight Skills

Competencies and Suggested Objectives
1. Complete the steps for a preflight and systems check of an aircraft to be flown. a. Check power systems voltage. b. Check GPS (HDOP and 3D satellite lock). c. Check compass bearing.
2. Formulate an emergency procedures flow chart and plan for recovery from unusual altitudes. a. Check proper voltage levels b. Check for 3D GPS lock c. Check compass heading. d. Check proper flight mode. e. Change to appropriate flight mode for recovery. f. Recover aircraft from unusual altitudes. g. Switch to manual flight mode and ensure throttle is at 50%. h. After control is maintained of aircraft, recover to Home location and land.
3. Assess flight dynamics based on vehicle loading. a. Calculate maximum takeoff weight, including payload. b. Weigh aircraft to ensure MTOW is not exceeded.
4. Design and execute a pre-programmed flight mission. a. Ensure that the mission does not exceed flight time limitations of aircraft. b. Set mission speed and altitude of aircraft. c. Program sensor trigger for geo tagging. d. Ensure mission heading aligns appropriately with prevailing wind direction. e. Launch mission. f. Program Home location or alternate landing zone location.

Unit 15: Data Processing Systems

*Written by Amelia Fox

Competencies and Suggested Objectives

1. Apply desktop and cloud-based data processing software to UAS flight mission.
   a. Define terms and explain concepts related to data processing software.
      Data processing
      Photogrammetry
      NDVI
      GIS
      GPS
      Cloud cap interpretation
      Orthosmasic model
      3D model
      Digital surface model (DSM)
      Open source software
      Commercial software
   b. Show how photogrammetry software can be used in UAS data collection.
   c. Demonstrate NDVI in data collection.
   d. Demonstrate how to use video processing software with data collected from a UAS flight.

2. Develop an understanding of GIS tools and technologies.
   a. Analyze and apply basic concepts of geographic information sciences.
      - Geographic data layers and computer compatibility
      - Relationships between geographic (spatial) and tabular data (non-spatial)
      - Synoptic (NADIR) versus linear landscape views
   b. Demonstrate the concepts of global positioning satellite systems (GPS) by determining locations.
      - Describe proper use and care of GPS receivers, computers, and scientific equipment.
      - Collect locational data in WGS84 geographic coordinates
      - Compare different hand-held devices for locational accuracy
      - Calculate average and standard deviation of repeated measurements
      - Map the points using Google Earth, ArcGIS Online, or QGIS.
   c. Create a basemap using online, open-source mapping resources
      - Install QGIS®, Google Earth®, and ArcGIS Online ® on local computers
      - Download basemap data from online repositories
      - USDA Geospatial Data Gateway, MARIS, Natural Earth, NRCS Websoil Survey
      - Explain the referential nature of spatial data and GIS software.
      - Store mapping data in logical file folders using convention protocols. https://library.stanford.edu/research/data-management-services/data-best-practices/best-practices-file-naming
   d. Develop the basemap using imagery and GPS waypoints
      - Download current NAIP imagery (USDA Geospatial Data Gateway)
      - Add GPS locational waypoints to the basemap.

e. Analyze the effects of changes in spatial, temporal, and spectral resolution on images.
f. Discuss scale-related issues of spatial data, data aggregation, and map generalization.
   - Choose the appropriate spatial scale of different spatial inquiries
     - Large- versus small-scales
     - Wide- versus narrow-landscape scales
g. Examine differences between coordinate systems
   - Geographic Coordinate Systems
     - NAD27, NAD83, and WGS84
   - Projected Coordinate Systems
     - State Plane
     - Universal Transverse Mercator (UTM)
h. Explain the basic concepts of data types and formats
   - Types of data (e.g., raster, vector, tabular, and geodatabase)
   - Data formats (e.g., DATETIME, Numerical, Text, Floating point, precision and scale
i. Create shapefiles with attributes to outline map features
   - Conduct simple locational analysis with GIS mapping tools.
   - Data extraction and proximity analysis
   - Spatial analysis and spatial statistics
j. Demonstrate geo-rectification, geo-referencing, and geo-coding.

3. Examine a physical mapping dataset created from remotely sensed datasets
   a. Explain the concepts of remote sensing.
      - Electromagnetic radiation and spectral signatures
      - Passive versus active sensing systems
      - Types of sensing platforms, altitudes, and spatial scale
   b. Interpret variations in reflection spectrum using images, graphs, and known objects presented.
   c. Download and process free remote sensing imagery.
      - GLOVIS or Earth Explorer
      - Merge remote sensing bands and classify imagery
      - Supervised and unsupervised classification
      - Classification by vegetation index
      - Error reports and confusion matrix
   d. Download and process topographical data
      - USDA Geospatial Data Gateway, MARIS
      - 3- and 10-meter DEM, LiDAR
      - Hillshade, Slope, and Contour mapping
   e. Measure biomass and relate to UAV or satellite data calibrated with a Normalized Difference Vegetation Index (NDVI).
      - Relate plant height and plant width to NDVI.
      - Relate plant greenness to NDVI.
   f. Assess imagery noise and demonstrate an ability to correct data images
      - Pre-processing effects (e.g., geo-rectification, atmospheric corrections)
      - Slicing, histogram stretch, color gun assignment
   g. Formulate a hypothesis and determine if datasets are pertinent to hypothesis.

h. Draw conclusions based on analysis and summary of geographic imagery results.

Unit 16: Sensors on UAS

Competencies and Suggested Objectives

1. Describe the types and sources of information that can be collected using sensors on UAS technology.
   a. List the types of sensors and their use.
      - LIDAR- high accuracy surface modeling
      - Radar – object detection and avoidance
      - Acoustic (ask Greg)
      - EO/IR – RGB and IR sensors for multiple band analysis

2. Explain the purpose and benefits of Global Positioning Systems.
   a. Define terms associated with geographic information systems.
      - GIS
      - Layer
      - Altitude
      - Latitude
      - Longitude
   b. Explain how geographic information systems are used in various industries.
   c. Access geographic information specific to the local area and be able to explain the benefit of that information
   d. Describe the purpose global positioning systems.
   e. Discuss how satellites are used in global positioning systems networks.
   f. Demonstrate how to identify a geographic location.
   g. Discuss the accuracy and security aspects of global positioning systems

3. Develop an understanding of how geographic information systems work.
   a. Demonstrate the basic concepts of global positioning systems (GPS) by determining locations, (e.g. latitude, longitude and elevation)
   b. Calculate various angle units and the average and standard deviation from repeated measurements.
   c. Explain the basic concept of remote sensing.
      - Characteristics of the electromagnetic spectrum
      - Passive versus active sensor systems
      - Types of sensor platforms
   d. Analyze the effects of changes in spatial, temporal and spectral resolution and effects on images due to changes in scale.
   e. Interpret the absorption/reflection spectrum using images and graphs.
   f. Explain the basic concepts of data and image processing
      - Types of data (raster, vector and attribute)
      - Variety of sources for geological data and imaging
   g. Formulate a hypothesis of geological factors/problems and determine data sets pertinent to the hypothesis.
   h. Explain how data sets are geo-referenced and geo-rectified.
   i. Assess the quality and accuracy of GPS and/or remote sensing data.
   j. Analyze and apply the basic concepts of geographic information systems.
      - Compatible geographic data layers of information utilizing computer software.

- Relationships between geographic data
- Geographic information image showing results of analysis

k. Draw conclusions based on analysis and summary of geographic image information results.

l. Research and defend a variety of applications for geographic information systems.

m. Describe the proper use and care of GPS receivers, computers and other scientific equipment.

n. Assess image problems and demonstrate the ability to adjust equipment to obtain correct and clear data images.

Unit 17: UAS Capstone Project

Competencies and Suggested Objectives
1. Plan a flight mission.
2. Research, select and integrate appropriate sensor for the mission.
3. Fly mission and collect data.
4. Perform a site survey mission.
5. Perform a structure scan mission.
6. Process data into a deliverable package to report findings.