ESF Course Proposal
Committee on Curriculum - ESF Faculty Governance
Office of Instruction & Graduate Studies

This course proposal form should be completed when introducing a new course or a revision of an existing course. The proposal will be reviewed by the Committee on Curriculum, or, in the case of minor revisions, will be approved administratively by the Associate Provost for Instruction.

This Course Proposal must be completed according to the guidelines provided in Course Proposal Form – Instructions and Guidance. Please see the last page of Course Proposal Form – Instructions and Guidance, for instructions on how this Course Proposal should be submitted to the Committee on Curriculum for review.

Date: 03/01/2021

1. Course Information:

1.1 Course Prefix and Number: ERE556
   Course Title: Unmanned Aerial Vehicle (UAV) Photogrammetry and Remote Sensing
   (If a new or renumbered course, please check with the Registrar regarding the use or reuse of the course number)

1.2 ☑ This is a New Course.
   OR
   ☐ This is a Major Course Revision
   OR
   ☐ This is a Minor Course Revision

   If this is a Course Revision, please see Course Proposal Form – Instructions and Guidance to determine if your revision is major or minor. Indicate below the reason(s) for the revision.

   (Please check all that apply)

   ☐ Course Number/Division ☐ Learning Outcomes ☐ Institutional Resources
   ☐ Title ☐ Concepts, Content ☐ Semester Offered
   ☐ Credit hours ☐ Catalog Description ☐ Course Inactivation
   ☐ Pre- or Co-requisite(s) ☐ Instructional Methods ☐ Course Reactivation
   ☐ Format ☐ General Education

1.3 General Education knowledge and skills area (if applicable): If none, check here ☑

   ☐ American History ☐ Humanities ☐ Other World Civilizations
   ☐ The Arts ☐ Mathematics ☐ Social Sciences
   ☐ Basic Communication ☐ Natural Sciences ☐ Western Civilization
2. Proposer Need Statement:

2.1 Describe why this course (or course revision) is needed to meet current or proposed goals and outcomes of the program or College, and, if a revision, provide an explanation of and justification for the revision. Unmanned Aerial Vehicle (UAV) or drone technology and the application of data acquired from this platform is growing rapidly. While there are multiple groups at ESF that are using UAV data in their research, there is no similar course being offered at ESF or at SU. UAV Photogrammetry and remote sensing focuses on data and image processing of UAV data with focus on environmental applications. The widespread appeal of the course is demonstrated by current (spring 2021) enrollment with students from various degrees (BS, MS and PhD), and departments at ESF, and also includes non-matriculated students.

PROGRAM LEARNING OUTCOMES:

Within the context of the course description presented above, this course will contribute to students achieving the following outcomes related to accredited ERE undergraduate degree

• Apply principles of mathematics, science, and engineering:
  - Mathematically (e.g. linear algebra and geometric calculations) manipulate UAV data and apply image processing techniques;
  - Apply basic and advanced imaging, photogrammetry and earth science skills to creatively solve problems
  - Apply engineering solutions to problems such as 3D modelling of objects (trees, building), digital surface model (DSM), digital terrain model (DTM) and ortho mosaic generation.

• Develop and conduct experiments, analyze and interpret data, and use engineering judgment to draw conclusions:
  - Demonstrate UAV flight mission design and planning.
  - Manage and analyze UAV remote sensing data to determine solutions to environmental challenges.

• Acquire, synthesize and apply new knowledge as needed, using appropriate learning strategies:
  - Become proficient users of UAV and remote sensing software tools (e.g. Pix4D) for data processing and analysis.

COLLEGE LEARNING OUTCOMES:

(1) Scientific Reasoning
  (a) Demonstrate the science of UAV imaging and photogrammetric concepts to describe and solve environmental challenges

(2) Quantitative Reasoning
  (a) Manage and analyze UAV data to understand and characterize various environments and ecosystems (e.g. water, forest, agricultural areas, construction sites)
  (b) Apply mathematical and photogrammetric modelling including 3D modelling, point cloud generation, noise reduction and collinearity equations to UAV images and data to extract information needed for environmental monitoring such as volume estimation, 3D modelling of trees, biomass estimation and crop health analysis

(3) Technological and Information Literacy
  (a) Become proficient users of software tools for UAV data spectral and geometric processing
2.2 List the pre-requisite or co-requisite courses (taught within the home department or taught by another department) and explain their relationship to the proposed course. One of ERE 365, ESF300, FOR 557 or equivalent

2.3 Explain the impact of this course in meeting the goals and outcomes of other Departments/programs (if any). This course could serve as an elective for students in many programs who use remote sensing and geospatial data analysis for environmental applications.

2.4 If the proposed course is designed to fulfill SUNY General Education Requirements, the Associate Provost for Instruction must review this proposal to ensure that General Education Requirements will be met for the specified knowledge area (See Instructions and Guidance). Please provide an explanation of how this course fulfills SUNY General Education Requirements. N/A

2.5 What are the staffing requirements (instructor, TA, Lab tech, etc.) for this course? If a new course, are there new staffing needs or are there adequate staff members already in place? If a revised course, are there additional staffing needs? Instructor and 10 hrs TA. Current ERE faculty teaches and no new staffing is needed

2.6 What Department (or extra-Department) resources are or will be made available to support the course or course revision? UAV image processing software (PiX4D). We have a class license of this software

2.7 Anticipated Enrollment (enter where applicable)

<table>
<thead>
<tr>
<th>Semester</th>
<th>Enrollment</th>
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<tbody>
<tr>
<td>Fall Semester</td>
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<tr>
<td>Spring Semester</td>
<td>10</td>
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<tr>
<td>Summer Semester</td>
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</tbody>
</table>

2.8 Anticipated frequency of class meetings. Two lectures and one lab per week
3. DETAILED COURSE DESCRIPTION

3.1 COURSE IDENTIFICATION AND FORMAT:

3.1.1 Course Prefix and Number: ERE 556
3.1.2 Course Name: Unmanned Aerial Vehicle (UAV) Photogrammetry & Remote Sensing
3.1.3 Credit Hours: 3
3.1.4 Semester (check all that apply): Fall ☐ Spring ☑ Summer ☐
3.1.5 Format (check as appropriate): Lecture ☑ Online ☐ Lab ☑ Field ☐
Other ☐ (explain)
3.1.6 Contact hours per week: 2 hrs lectures + 3 hrs lab
3.1.7 Prerequisite(s) – if none, please enter “None” (Be specific, as Upper Division courses and Graduate courses will likely have some pre-requisite knowledge) One of ERE 365, ESF300, or FOR 557 or equivalent

3.2 SCOPE:

3.2.1 Level of Instruction (check one, or two if a shared resource course):
   Lower Division ☐ Upper Division ☐
   Beginning Graduate ☑ Advanced Graduate ☐

3.2.2 Relation to curriculum or to other ESF or Syracuse University courses:
   a. Is this a required course? No ☐ Yes ☑.
      If Yes, please list the program(s) for which it is a requirement:
   b. Is this an elective course within your department? No ☐ Yes ☑.
   c. Is enrollment in this course restricted? No ☐ Yes ☑.
      If Yes, please explain:
   d. Are other ESF or SU courses similar or identical to this course? No ☐ Yes ☑.
      If Yes, please identify the courses:
   e. Is this course a shared resource offering (i.e. is there a graduate or undergraduate concurrent offering)? No ☐ Yes ☑.
      If Yes, what is the course number of the concurrent offering?

3.3 STUDENT LEARNING OUTCOMES:

Identify the student learning outcomes associated with this course.

At the conclusion of the course, students should be able to:

• Explain different components of a UAV system, enabling factors and technologies for UAVs, regulatory issues, different UAV sensors (multispectral, LiDAR, RADAR, Acoustic) and platforms (rotary and fixed-wings) as well as UAV system control.

• Explain the reference coordinate system used in UAV imagery and aerial mission planning as well as image and sensor measurements.
• Apply fundamental UAV image photogrammetry procedures including bundle block adjustment, collinearity condition, sensor positioning and orientation, 3D surface reconstruction and ortho-image generation

• Explain the emerging trends and technologies of UAV systems and the societal, technological, and regulatory challenges in working with UAV data

• Process UAV data and provide end products using commercial software such as Pix4D. The products include DSM and ortho-mosaic, DTM and tree biomass measurement, point cloud generation and 3D modelling, processing thermal data and crop health analysis.

• Explain and provide a presentation on a selected topic of UAV data applications in the areas such as forestry and agriculture, surveying and reconstruction, or environmental monitoring.

3.4 MAJOR CONCEPTS, PROCESSES or TOOLS:

Identify the course content and themes (e.g. Table of Contents) consistent with the learning domains and outcomes.

Lecture Content

1. Introduction to UAV Systems and geomatics and geospatial analysis, regulatory issues

2. Platforms and sensors: UAV platforms, sensors, control and autopilot

3. Data collection and processing: Reference Coordinate System and Transformations, Aerial mission planning, Image and sensor measurement

4. Analytical photogrammetry

5. Sensor positioning and orientation

6. 3D surface reconstruction

7. UAV spectral image analysis

8. UAV applications and student presentations

Lab Content:

Lab 1: Getting started with Pix4Dmapper and image geo-referencing

Lab 3: DSM and ortho-mosaic generation

Lab 4: DTM and contour line generation

Lab 5: 3D model generation

Lab 6: Spectral Analysis: Analysis of thermal images
Lab 7: Crop health analysis

3.5 INSTRUCTIONAL METHODS:

Identify the methods used to meet the course outcomes, as well as the principal instructional methods.

The instructional methods include lectures, guest lectures, discussion forum, labs, and student presentations. Evaluation methods include two exams, quizzes, discussion grading, presentation evaluation and grading. The materials include power point slides, online materials such as YouTube and articles as well as software use (Pix4D or a similar software) and UAV imagery. In the lab, students will use software and UAV imagery and process data for various applications including Image geo-referencing, point cloud generation, mosaic generation, DTM and contour line generation, 3D model reconstruction, spectral analysis and thermal processing, and crop health analysis. The last part of the course consists of student research and presentation on student selected topics typically in an area related to College focus areas (environmental sciences and forestry and its sub-disciplines such as environmental resources engineering, environmental studies, forest study and management, etc.)

3.6 CATALOG DESCRIPTION

Provide the course description using the precise format to be included in the ESF catalog (i.e. course number and title; format; brief description; semester(s) offered; and pre-/co-requisites). Please do not exceed 1000 characters.

Unmanned Aerial Vehicle (UAV) Photogrammetry & Remote Sensing. Two hours of lecture and discussion, and three hours of lab per week. Introduction to Unmanned Aerial Vehicles (UAV) with focus on data processing and photogrammetric analysis. Introduction to UAV systems including types and classification, regulatory issues, sensors and platforms. Data collection and processing including mission planning, photogrammetric triangulations and bundle adjustment, sensor positioning and orientation, 3D surface reconstruction and image matching, robotic mapping and ortho generation. Emerging UAV trends and technologies such as power and payload issues as well as outlook and societal, technological, regulatory, and market challenges. Spring. Prerequisite: Completion of an introductory geospatial course, ERE 365, ESF 300, or FOR 557, or equivalent.

3.7 COURSE HISTORY:

Provide the dates of prior approval of this course, and its revision history.

3.7.1 Relationship to current ESF courses

This course is replacing a current ESF course  □ YES  X NO

If NO, then proceed to section 4 below.

If YES, then provide below the number and name of the course to be deactivated and removed from the catalog once this course proposal has been approved:
Course Number (of the course to be replaced)

Course Name (of the course to be replaced)

If the course to be replaced is used by departments other than the department sponsoring this proposal, please indicate below which departments are affected and the date they were notified about the course replacement.

Department:            Date of Notification:
Department:            Date of Notification:
Department:            Date of Notification:
Department:            Date of Notification:
4. Institutional Impacts:

This section pertains to forecasting institutional resource needs to support the course or course revision. Provide clear statements regarding the needs and current availability (or absence) of resources. Note that, if this is a course revision, only the impacts of the revision should be included.

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<thead>
<tr>
<th>Resource Type</th>
<th>Description</th>
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<tr>
<td>Staffing needs</td>
<td>Instructor and a 10 hr TA</td>
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<td>Classroom resources (e.g. physical facilities in a laboratory, lecture hall, flexible space, academic computing)</td>
<td>Classroom or online</td>
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<td>Technology Resources</td>
<td>Computer for lab</td>
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<td>Computing Resources (software licensing, hardware, access)</td>
<td>PiX4D or a similar UAV image processing software</td>
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<td>Library Resources (subscriptions, services)</td>
<td>N/A</td>
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<td>Transportation Requirements (budget, fees, fleet vehicles)</td>
<td>N/A</td>
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<tr>
<td>Forest Properties or Field Practicum Facilities</td>
<td>N/A</td>
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5. Health and Safety Considerations:

Will any of the conditions or situations outlined below be present in association with the course?  

5.1. **Will substances with any of the following properties be used during instruction:** flammability, toxicity, corrosivity, reactivity, registered pesticide, legally controlled, or other characteristics with the potential to cause harm or injury?  

5.2. **Will any physical hazards be present during instruction?** (e.g., machines that need safety guards; razor blades or syringes; compressed gases, etc.).

5.3. **Will any biological hazards be present during instruction?** (e.g., handling animals (rabies or hantavirus); cultures or stocks of infectious agents (fungal spores, viruses, bacteria, etc.).

5.4. **Will any radiation hazards be present during instruction?** (e.g., radioisotopes, X-rays, ultraviolet rays, lasers, etc.).

5.5. **Will any electrical equipment that, due to its design, location, or method of use, pose any threat to safety during instruction?** (Give considerable thought to electrical use outdoors, or any potentially wet location.).

5.6. **Will there be any personal safety issues related to the class?** (e.g., due to time of day or location, at the end of any organized class exercise, will students be in danger of physical assault, etc.).

5.7. **Will any students be driving official state or research sponsored land or water vehicles during any class or instructional exercise?**

5.8. **Will any type of personal protective equipment be necessary during class exercises?** (e.g., hard-hats, eye/face protection, hearing protection, hand/foot protection, lab coat, visibility clothing, etc.)

If the answer was “Yes” to any of the HEALTH AND SAFETY questions, please explain:

For lab and field courses to which all answers are “no”, you should explain that here, also. Normally, we would expect some safety precautions for such courses. The lab is conducted using software and no field work is involved.
6. Coordination and Consultation

Emails/letters, as noted below and attached to this proposal, or signatures below, indicate that the affected departments, programs or units have been notified of this proposal and have had an opportunity to assess the impact of the proposal on their respective units.

**Affected Academic Department(s) or Program(s) – other than the sponsoring department:**

<table>
<thead>
<tr>
<th>Department/Program 1</th>
<th>Name of Chair/Program Director</th>
<th>Chair Signature</th>
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<th>Department/Program 2</th>
<th>Name of Chair/Program Director</th>
<th>Chair Signature</th>
<th>Date</th>
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<th>Department/Program 3</th>
<th>Name of Chair/Program Director</th>
<th>Chair Signature</th>
<th>Date</th>
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[if more than three Departments/Programs, please continue on a separate page]

**Other Units:**

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<th>Function</th>
<th>Signature Information</th>
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<tbody>
<tr>
<td>Associate Provost for Instruction &amp; Dean of the Graduate School (for Gen Ed courses only)</td>
<td>Date</td>
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<tr>
<td>Registrar</td>
<td>Date</td>
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<td>Library Director</td>
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<td>Computing and Network Services</td>
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<td>Physical Plant</td>
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<td>Forest Properties</td>
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<td>Environmental Health and Safety</td>
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[If more than three other units, please continue on a separate page]
7. Proposer Information and Sponsoring Department Chair Affirmation:

Contact Person:
Name:Bahram Salehi
Department:ERE
Email:bsalehi@esf.edu
Phone:6650

This proposal has been reviewed and approved by the sponsoring Department. Affected departments have been notified and given the opportunity to provide feedback. Department resources are or will be made available to support the course, or a plan is in place to meet the resource needs as identified in the Institutional Impacts section of this proposal (see Section 4, above).

Name:Lindi Quackenbush
Date:26 Feb 2021
Department Chair (or designated curriculum representative)
Signature:

8. Approvals:

Curriculum Committee
Date

Faculty Governance
Date

Provost
Date