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: ERE555  
   Course Title: RADAR 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)

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

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

<table>
<thead>
<tr>
<th>☐ American History</th>
<th>☐ Humanities</th>
<th>☐ Other World Civilizations</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ The Arts</td>
<td>☐ Mathematics</td>
<td>☐ Social Sciences</td>
</tr>
<tr>
<td>☐ Basic Communication</td>
<td>☐ Natural Sciences</td>
<td>☐ Western Civilization</td>
</tr>
</tbody>
</table>
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. This is a new course on RADAR remote sensing which complements our current remote sensing courses in optical remote sensing. This is a unique course on radar remote sensing theory and applications for environmental monitoring and to my knowledge there is no such a course in NYS universities. It meets the needs of undergraduate and graduate students at ERE as detailed below. In addition, students from other departments who use remote sensing and geospatial data analysis (for environmental applications) can benefit from this course.

This course will contribute to students achieving the following outcomes related to the ABET-EAC accredited ERE undergraduate degree:

• Identify, formulate, and solve engineering problems:
  - Demonstrate spatial and image processing skills for problem solving;
  - Manage and analyze RADAR remote sensing data to determine solutions to environmental challenges.

• Apply principles of mathematics, science, and engineering:
  - Mathematically (e.g. linear algebra, probability and statistics) manipulate geospatial data (i.e. RADAR remote sensing data) and image processing;
  - Apply basic and advanced earth and space sciences to creatively solve problems

• Develop and conduct experiments, analyze and interpret data, and use engineering judgment to draw conclusions:
  - Analyze, synthesize and interpret remote sensing data.

• Acquire, synthesize and apply new knowledge as needed, using appropriate learning strategies
  - Become proficient users of software tools for solving environmental challenges using RADAR remote sensing.

COLLEGE LEARNING OUTCOMES:

(1) Scientific Reasoning
  (a) Demonstrate the science of RADAR imaging and electromagnetic wave and its interaction with objects to understand the environmental changes

(2) Quantitative Reasoning
  (a) Manage and analysis satellite data to understand and characterize the environment and ecosystems (water, forest, wetland, sea, etc.)
  (b) Apply mathematical modelling including linear algebra and image processing to satellite data to extract information needed for environmental mapping and monitoring.

(3) Technological and Information Literacy
  (a) Become proficient users of software tools for RADAR image analysis.

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. ERE 365 (Principles of Remote Sensing) or an equivalent course.
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 hours TA. 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? RADAR image processing software such as PCI Geomatics or a similar software. We have a class license of this software

2.7 Anticipated Enrollment (enter where applicable)

<table>
<thead>
<tr>
<th>Fall Semester:</th>
<th>Spring Semester:</th>
<th>10</th>
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<tbody>
<tr>
<td>Summer Semester:</td>
<td></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 555
3.1.2 Course Name: RADAR 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) ERE 365 (Principles of Remote Sensing) or an equivalent course with general understanding of remote sensing concepts

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 the sources and characteristics of images acquired by different active (SAR-synthetic aperture radar) sensors. Characteristics include target and sensor parameters such as azimuth and range resolutions, surface roughness, wavelength, polarization, penetration depth, and incidence angle.

• Explain the concept and principle of PolSAR image and data processing and information extraction techniques such as polarization (HH, HV, and VV), scattering mechanisms (surface, double-bunce, and volume scattering), speckle filtering, polarimetric decomposition, and PolSAR image classification.
• Select proper image sources according to the applications and use proper software and processing approaches to solve the problems, and deliver the image products.

• Apply SAR data processing for real-world applications using a SAR processing software package (e.g. PCI Geomatics). Examples of applications include wetland, agricultural, and forest classification, flood monitoring, sea and ocean surface characterization, and sea ice detection and discrimination.

• Explain the scattering behaviors of targets and land cover to interpret the RADAR imagery for different applications in environmental monitoring.

• Assess the advantages and limitations of SAR remote sensing, problems to be further solve and the current research directions.

• Assess the current status and future prospect of SAR remote sensing.

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.

Course Content :

1. Introduction to Imaging RADAR System
2. The Radiation Framework
3. RADAR Imaging – System Parameters
4. RADAR Imaging- Target Parameters
5. Geometric Correction of RADAR Imagery
6. Scattering Mechanisms
7. Introduction to Polarimetric SAR
8. Polarization Descriptors and Scattering Operators
9. Polarimetric SAR Speckle Filtering
10. Polarimetric Decomposition and Eigenvector-based Decompositions
11. PolSAR Image Classification
12. Selected PolSAR Applications
13. Course Review
Lab Content:

PolSAR Remote Sensing Image Analysis

Lab 1: Read and Display SAR Image (3%)

Lab 2: Manipulating a Single-Channel SAR Image and SAR Texture Analysis (3%)

Lab 3: SAR Data and Radiometric Enhancement (6%)

Lab 4: Polarimetric Decomposition (6%)

Lab 5: Coherent Target Analysis (5%)

Lab 6: PolSAR Classification (7%)

Lab 7: SAR Change Detection (5%)

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, discussion, and labs. The evaluation methods include two exams, lab reports, assignments, quizzes, and graded discussions. The materials include power point slides, online materials such as YouTube and articles as well as software use (PCI Geomatics or a similar radar processing software) and satellite imagery. In the lab students will use software and satellite imagery and process data for various applications including radar image interpretation land cover mapping, forest biomass estimation, wetland type mapping, agricultural crop classification, sea and ocean surface characterization and sea ice type and age detection and discrimination.

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.

ERE 555 Radar remote sensing. Two hours of lecture and three hours of lab per week. Theory and applications of Synthetic Aperture RADAR (SAR) Remote Sensing and advanced Polarimetric SAR (PolSAR) for environmental monitoring. Fundamental concepts of SAR imaging systems such as target and sensor parameters, geometric correction, and scattering mechanisms, and advanced topics of Polarimetric SAR such as polarization descriptor and scattering operators, speckle noise filtering, Polarimetric decomposition, PolSAR image supervised and unsupervised classification. Selected real-world applications of PolSAR data for land cover mapping (e.g. agriculture, forest, wetlands, and water bodies), sea and ocean surface, and sea ice detection and discrimination. Spring. Prerequisite: ERE 365 or equivalent.
3.7 COURSE HISTORY:

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

3.7.1 Relationship to current ESF courses

This course is replacing a current ESF course: ☐ YES ☒ 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.

<table>
<thead>
<tr>
<th>Resource Type</th>
<th>Requires/Availability</th>
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<tbody>
<tr>
<td>Staffing needs:</td>
<td>Instructor and a 10 hrs TA</td>
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<tr>
<td>Classroom resources (e.g. physical facilities...)</td>
<td>Classroom or online</td>
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<tr>
<td>Technology Resources:</td>
<td>Computer lab</td>
</tr>
<tr>
<td>Computing Resources (software...)</td>
<td>PCI Geomatics or a similar RADAR remote sensing software</td>
</tr>
<tr>
<td>Library Resources</td>
<td>N/A</td>
</tr>
<tr>
<td>Transportation Requirements</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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</tbody>
</table>
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>
<th>Date</th>
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<thead>
<tr>
<th>Department/Program 2</th>
<th>Name of Chair/Program Director</th>
<th>Chair Signature</th>
<th>Date</th>
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<table>
<thead>
<tr>
<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:**

<table>
<thead>
<tr>
<th>Position</th>
<th>Chair Signature</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Associate Provost for Instruction &amp; Dean of the Graduate School (for Gen Ed courses only)</td>
<td></td>
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<tr>
<td>Registrar</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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<tr>
<td>Environmental Health and Safety</td>
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</table>
7. Proposer Information and Sponsoring Department Chair Affirmation:

Contact Person:
Name: Bahram Salehi ______________________________
Department: ERE_______________________
Email: bsalehi@esf.edu _______________________________
Phone: 6550___________________________

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:_________________________________________________________ Or letter attached □
Department Chair (or designated curriculum representative)

8. Approvals:

__________________________________________________ ____________ ______
Curriculum Committee        Date

__________________________________________________ ____________ ______
Faculty Governance        Date

__________________________________________________ ___________ _______
Provost         Date