Remote Sensing of the Environment

Course Alpha & Number

Chair

Signature

Date

Remote Sensing of Environment

Prerequisite Course(s)

None

Prerequisite Waiver

None

Instructor Approval

Department Approval

Other Approval

No Waiver

Graduate Division (600 level and above)

Graduate Dean

Signature

Date

General Education

Mānoa Chancellor's Office

Chancellor

Signature

Date
INSTRUCTIONS FOR COMPLETING THE UHM-1 FORM

Adherence to the following guidelines and format will facilitate the approval process. Type all text in upper/lowercase format (except course alphas, which are always uppercase).

Submit a separate form for each course.

For undergraduate courses, submit at least an original and three copies; for graduate courses, submit at least an original and six copies.

To be included in the appropriate Schedule of Classes or Catalog, UHM-1 Forms must be submitted to the Mānoa Chancellor's Office (MCO) by December 31 for the next fall semester and May 31 for the next spring semester. Check with individual college/school academic services office and Graduate Division regarding internal deadlines.

1. Course Subject. Between two and four letters (uppercase), eg. BUS, SPAN.

2. Course Number. Three-digit number may be followed by letter for certain courses (L for lab, A for honors, B–K, M–U, or X–Z for alpha course sections). -97 and -98 are reserved for experimental courses.

3. Effective Term. Type in appropriate semester and year. For example, type “spring 2004” for 2004 spring semester. Codes from earlier versions of the UHM-1 Form should not be used. Note deadlines above.

4. Frequency. Indicate how often the course will be offered.

5. Course Title. 5a. Type in full title of the course, in upper/lowercase format, the way it will appear in the Catalog. 5b. Type in the title for BANNER, not to exceed 30 characters, abbreviating as necessary.

6. Offering. Check only one. Check “Regular” for permanent course, “Single” for a course to be offered only once, or “Experimental” for an experimental course numbered -97 or -98. When approved, an experimental course can be offered for a maximum of two academic years. To modify an experimental course into a regular course, submit a UHM-2 Form.

7. Undergraduate Core or Graduation Requirement. Check only one. Check #1 if approval as a Diversification or Hawaiian/Second Language course is requested; #2 if approval as a Foundations course is requested; #3 if the department does not want the course to be considered for a designation. If #2 is checked, appropriate supporting documents must be sent to the General Education Office. Indicate only one Diversification designation (DA, DH, DL, DB, DP, DY, or DS) or one Foundations designation (FW, FS, or FG) in the space provided. See the General Education website, www.hawaii.edu/geden, for Diversification and Foundation hallmarks. Instructions for Focus designations are also available on the website.

8. Grade Option. Check all boxes that apply. For most courses, the first 3 options will be checked. For mandatory CR/NC grading, only “Credit/No Credit” is checked. Leave “Audit” blank only if no auditors are permitted.

9. Number of Credits. Type the number of credits the course carries. For variable credit offerings, please specify range, e.g., “V(1-6).”

10. Repeat Limit. Type number of times a course may be repeated after it has been completed successfully. For most courses, this is zero. A “1” means a course can be repeated once, i.e., it can be taken twice. For courses designated repeatable more than once, a rationale is required in the justification section (item 18).

11. Credit Limit. Taking into account the proposed repeat limit from No. 10, type in the maximum number of credits that a student may earn for this course. For variable credit course courses, this number represents the maximum credits the college/school allows.

12. Corequisite Course(s). If an existing course must be taken concurrently with the course covered by this UHM-1 form, enter alpha and number. If the corequisite is one of two courses, write both alphas and numbers separated by “or.” If two or more courses are all corequisites, list all, separated by “and.” For example, the corequisites for ABC 300 are “ABC 300L and ABC 301 and ABC 301L.”

13. Major Restriction(s). Course may be restricted to students in specific majors. Up to four designated fields of study may be specified. Type the three-digit code(s) from the PROG table when indicating major(s).

14. Prerequisite Course(s) and/or Waiver. Be clear and specific. Enter course alpha and number for each prerequisite. Use “and” or “or” rather than punctuation marks to designate relationships between prerequisites, e.g., “Either ABC 100 or XYZ 100” or “Both ABC 100 and 101.” Type “or concurrent” after each prerequisite course that may be taken concurrently. Also specify what type of waiver is acceptable in lieu of specific prerequisites (check only one).

15. Contact Hours and Instruction Type. In the space provided beside each instruction type, type the number of minutes per week for each applicable instruction type. For example, ABC 300 is a 3-credit course consisting of two 50-minute lectures per week and one 3-hour laboratory per week. Therefore, the contact hours for lecture would be “100 minutes” and the contact hours for laboratory would be “180 minutes.” For a variable credit course, use a check mark (✓) to identify all applicable instruction types.

16. Cross-Listed Course(s). List course alpha and number of cross-listed course(s). Have chair of cross-listed department sign and date. It is not necessary for the cross-listed department to submit a separate UHM-1 form if the counterpart course already exists. A course may be cross-listed with no more than two other courses.

17. Catalog Description. This section will appear in the Catalog. Enter only the description of the course. Refer to the sample below.

SAMPLE COURSE DESCRIPTION (for ABCD 485 Introduction to Paperwork)

Combined lecture-lab course on the theory and practice of paperwork. Open to nonmajors.

Describe the course; do not simply repeat course title. Limit description to 35 words; 85 words for alpha courses. Indicate class size and format (e.g., lecture, discussion, seminar, lab, workshop studio). Specify if it is a continuation of another course, if it includes field trips, group projects, delivery via HITS, other out-of-the-ordinary learning experiences; and/or list key words from syllabus.

18. Justification. Provide rationale for request including a description of how the proposed course is linked to stated learning outcomes of the degree program and expected course enrollment. Identify additional resources (if any) that will be required to teach the course. Attach course syllabus. Refer to instructions from the college and Graduate Division. If course is, or will be, a major or degree requirement of another academic unit, specify affected unit. Attach additional sheets as needed.

SEPTEMBER 2003
18. Justification

2. Why is this course being requested?

The on-going diversification of Hawaii’s agriculture, forestry, and associated land use changes require sound information on the land resource base, coastal zones, and environmental quality. Remote sensing has been proven highly effective for the systematic, objective characterization and monitoring of land, coastal, and atmospheric conditions. Recent advances in both remote sensing and computer technologies have made it possible to work on remotely sensed data in any desktop or laptop computers and, thus, are making remote sensing in routine use in terrestrial and coastal zone assessments. Land and coastal remote sensing will soon become “must-have” knowledge and skills for graduating students in the natural resources and environmental management fields.

3. How will the content be organized?

The proposed course emphasizes on students’ learning of both the theoretical backgrounds and practical skills of remote sensing and consists of lecture (125 hours per week, or 2.5 credits, on average) and bi-weekly three-hour lab (75 hours per week, or 0.5 credits on average) parts. The lecture part is designed to introduce to students the theoretical background and physical basis of remote sensing and advanced data/image analysis techniques used in applications of remote sensing. Each lab exercise covers the same materials taught during the past two weeks. The first lab exercise is for students to learn satellite sensor models, i.e., how each sensor images the Earth. Four lab exercises are allocated for radiometry in which students learn to make field radiometric measurements, process the data, and learn to model the observed radiometric phenomena. The rest of lab exercises are about processing, statistical analyses, and information extractions of satellite imagery. The course requires students to conduct a term project. A draft syllabus of the course is attached in the end.

4. What other courses at UHM closely parallel the proposed course and in what way will the latter make a distinct contribution?

There are two introductory remote sensing courses (GEOG 470 Remote Sensing; GG 460 Geological Remote Sensing). We communicated with the instructors of the respective courses and obtained their course syllabi when the proposed course was being designed. The proposed course has been designed to build upon and complement the two existing courses.

5. Where or how does the proposed course fit into the current and future curriculum?

This proposed course, NREM 677, is one of the core courses for the Geospatial Analysis and Modeling concentration area to be adapted in the NREM graduate program. This concentration area has the geographic information systems (GIS)
(NREM 477) and remote sensing (GEOG 470 & NREM 677) components. While the former is focused on the management and analyses of geospatial data, the latter is focused on the analysis of remote sensing imagery for the derivation of information in the form of geospatial data. NREM 677 is designed to acquaint graduate students with advanced techniques on physically-based information extraction from remotely sensed imagery.

6. Why is the number of credits and level justified? Explain the prerequisites and the absence thereof.

The proposed course, NREM 677, is a 3-credit, combined lecture-laboratory course:

<table>
<thead>
<tr>
<th>Component</th>
<th>Contact Time per Week</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture part</td>
<td>125 minutes</td>
<td>2.5</td>
</tr>
<tr>
<td>Laboratory part</td>
<td>75 minutes</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3</strong> credit hours</td>
<td></td>
</tr>
</tbody>
</table>

As the course is a graduate-level, the following are prerequisites to NREM 677:

- PHYS 151 or one physics course
- NREM 203 or one calculus course
- NREM 310 or one statistics course

We will also be recommending one introductory remote sensing course:

- GEOG 470 or GG 460 or one introductory remote sensing course
7. How will the course assist students to achieve the critical skills and competencies expected of CTAHR graduates?

<table>
<thead>
<tr>
<th>SKILL CATEGORIES</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written Communications</td>
<td>The lab report and term paper requirements help students develop skills to write in a logical manner using technical writing styles as analyses of remote sensing requires logical thinking that needs to be reflected in the lab report writing.</td>
</tr>
<tr>
<td>Oral Communications</td>
<td>The term project presentation requirement will provide an opportunity for students to give well-organized presentations, utilize visual materials effectively, utilize appropriate speaking styles, and listen effectively.</td>
</tr>
<tr>
<td>Analytical/Problem Solving Skills</td>
<td>Lecture materials on the derivations of remote sensing theories and data analysis methodologies, and lab exercises will make students develop analytical/problem solving skills.</td>
</tr>
<tr>
<td>Personal Characteristics</td>
<td>Learning remote sensing theories and data processing skills is very time-consuming and requires patience. Students will be encouraged and instructed by the instructor to think on a step-by-step basis and manage time effectively.</td>
</tr>
<tr>
<td>Computer Skills</td>
<td>Processing of remotely sensed data require intensive, advanced computing skills. Students will learn and develop advanced skills in using spreadsheet software and specialized image processing software.</td>
</tr>
<tr>
<td>Global Perspective</td>
<td>Some of the lab exercises will address global natural resource issues.</td>
</tr>
</tbody>
</table>

8. How will students be evaluated?

Students’ learning accomplishments will be evaluated by two mid-terms (15% each), eight lab exercises (45%), and final term project paper/presentation (25%). The two mid-terms will be used to evaluate student’s understanding of the subject matters, in particular theories and methodologies. A large weight is given to lab reports as students are expected to apply the learned theories and methods to actual data processing. The final project paper/presentation will be used to measure whether students develop an integrative understanding of both the theoretical background and practical applications.

9. What are the minimum qualifications for teaching this course? Is a qualified instructor now available?

The minimum qualifications for teaching this course are:

- Ph.D. in natural resource management, environmental science, soil and water science, or equivalent degree;
- Research experiences involving the extensive uses of remote sensing data;
- Familiarity with science computing

A qualified NREM faculty member, Dr. Tomoaki Miura, is available to teach the course.
10. How will the course be financed, assuming no further cutbacks?

CTAHR is equipped with a networked computer lab. At least, 24 computers in the lab are of high quality, which are also equipped with spreadsheet software.

Dr. Tomoaki Miura’s lab has all necessary field equipment for the field radiometry exercises.

The software to be used in modeling exercises are available free from U.S. Department of Agriculture Agricultural Research Services (USDA-ARS). There are free image processing software available (e.g., MultiSpec) that can be used. Dr. Miura’s lab also maintains 10 licenses of the ENVI image processing software, one of the most widely-used commercial software packages in the field of remote sensing.

11. Has the course been offered before? Is there a demand for it?

The expected course enrollment is 10-20 students. An experimental version of the course was offered in Spring 2008 (NREM 691 Remote Sensing of the Environment). Since the course was advertised only within the NREM department for the experimental version, the enrollment was 5 students. Students who have taken NREM 477 frequently ask whether there is a remote sensing course by the NREM department. Upon the implementation of the Geospatial Analysis and Modeling concentration area, we expect to have steady demands for the course. We are proposing to offer the course every other year. Upon official course approval of NREM 677, we will advertise the course campus-wide. This should attract additional students body from other departments as well as other colleges.

12. Is the course cross-listed with another department?

No.
NREM 677 Remote Sensing of the Environment (3 Credits)
– Course Syllabus –

INSTRUCTOR
Dr. Tomoaki Miura
Office: Sherman 237 / Phone: 956-7333 / Email: tomoakim@hawaii.edu

HOURS
Lecture:   TR 9:00 am – 10:15 am  AgScience 220
Lab (bi-weekly):  R 1:30 pm – 4:20 pm  AgScience 215
Office:    T 12:00 pm – 2:00 pm  Sherman 237

COURSE DESCRIPTION
This is an intermediate level course on remote sensing. The course will cover fundamentals, techniques, and applications of remote sensing for improved natural resource utilizations and environmental monitoring. Specific topics include: energy-matter interaction, remote sensing systems, optical properties of vegetation and soil, basic/advanced image processing techniques, remote sensing applications to rangeland, forest, and coastal ocean management.

COURSE OBJECTIVES
The primary objective of this course is for students to be acquainted with remote sensing theories and applications for developing an improved understanding of the surface conditions and processes on the Earth. The secondary objective is for students to become able to utilize remote sensing techniques for the study of the spatial and temporal dynamics of terrestrial and coastal ecosystems. Specific learning outcomes include good understandings of:

- Energy-matter interaction
- Remote sensing systems (four resolutions)
  - Solar reflective remote sensing
  - Thermal remote sensing
  - Microwave and radar remote sensing
  - LiDAR remote sensing
- Digital image processing
- Remote sensing of
  - Plant canopies and soils
  - Rangeland
  - Forest and forest structures
  - Coastal ocean

PREREQUISITES
The following are prerequisites:
• PHYS 151+L or one physics course
• NREM 203 or one calculus course
• NREM 310 or one statistics course

In addition, the following courses are highly recommended before taking NREM 677 although not required:
• GEOG 470 or GG 460 or one introductory remote sensing course
ASSIGNMENTS AND GRADING POLICIES
Mid-term Exam I 15%
Mid-term Exam II 15%
Lab Exercises 45%
Final Project Paper 25%

FINAL GRADING
A+ \( x \geq 95 \)  B+ \( 87 > x \geq 84 \)  C+ \( 77 > x \geq 74 \)  D+ \( 67 > x \geq 64 \)
A  \( 95 > x \geq 90 \)  B  \( 84 > x \geq 80 \)  C  \( 74 > x \geq 70 \)  D  \( 64 > x \geq 60 \)
A- \( 90 > x \geq 87 \)  B- \( 80 > x \geq 77 \)  C- \( 70 > x \geq 67 \)  F  \( x < 60 \)

LAB EXERCISES
- Various exercises will be conducted in the lab section to familiarize you with the measurement, analysis, interpretation, and display of remote sensing data. They will be held approximately bi-weekly.
- Exercises include field radiometry (including field trip), digital image processing, and the use of models.

TEXTBOOK
Reading assignments will include selected chapters from the following books and selected journal articles:

[General introduction]

[Radiometry & energy-matter interaction]

[Image processing]

[Applications]
ATTENDANCE AND OTHER POLICIES

- Non-attendance of 3 or more successive classes are grounds for withdrawal.
- Attendance for class exercises is mandatory.
- Attendance for exams is mandatory.
- Makeup class exercises, makeup exams and/or late submissions will only be accepted for the following cases:
  1) Emergency cases (i.e., doctor appointments, family emergencies, etc.); require a prior approval of the instructor with appropriate evidence(s) provided by students,
  2) Absences due to illness or sickness without a doctor’s note, or other emergency cases; require student’s contacting the instructor before or within 24 hours after missed events.
- Late submissions due to computer crash, software crash, and/or lost data will not be accepted.

ACADEMIC INTEGRITY

- We encourage sharing of intellectual views, principles, and applications of course materials among students.
- Graded homework exercise must be executed independently unless noted by the instructor.
- For the details, refer to Page 563 of UHManoa 2007-2008 Catalog, “Academic Integrity.”
COURSE OUTLINE (Tentative, Subject to Change)

1. Introduction to Concepts and Systems
   - Electromagnetic energy and spectrum
   - Image characteristics (four resolutions)
   - Spectral reflectance curves

2. Remote Sensing Sensors
   - Satellite orbits and satellite system examples
   - Airborne and ground sensors
   - Future sensor systems
   Lab 1. Web surfing on Sensors and Resolutions

3. Energy Interactions with the Earth’s Surface
   - Energy terms and radiation laws
   - Reflectance definitions
   - Principles of radiometric measurements
   Lab 2. Radiometry Exercise and Reflectance Derivations

4. Optical Properties of Soils
   - Mineralogic and organic features
   - Soil moisture
   - Litter
   - Soil line concept

5. Optical Properties of Plant Canopies
   - Leaf spectra – 7 regions of information
   - Other plant tissue spectra
   - Canopy spectra (multiple layers, ground cover)
   - Radiative transfer model
   - Senescence, stress, and phenology
   Lab 3. SAIL Canopy Model

--- Midterm Exam I ---

6. Spectral Vegetation Indices
   - NIR-red feature space / tasseled cap
   - NDVI, SR, PVI
   - Advanced indices: SAVI, ARVI, EVI, EVI2
   - Other indices: NDWI, LSWI
   Lab 4. Soil Line and Vegetation Index Computations

7. Digital Image Processing
   - Data structures
   - Image enhancement
   - Principal components analysis and spectral mixture analysis
   - Image classification
   Lab 5. Image Processing Exercise

8. Vegetation Biophysical Properties
   - fAPAR measurements & equations
   - LAI
   - GPP, NPP, and biomass
   - LiDAR remote sensing
   Lab 6. Remote estimation of canopy biophysical properties

9. BRDF and Atmosphere
   - Sun angle and view angle variations
   - Atmospheric radiative transfer
   - Atmospheric correction
   Lab 7. “6S” atmosphere radiative transfer model

--- Midterm Exam II ---

10. Land Cover and Land Use
    - Accuracy assessment
    Lab 8. Image Classification (Tentative, TBD)

11. Forest and Forest Ecosystem Monitoring
    - Forest canopy chemistry
    - Forest phenology monitoring

12. Coastal Ocean Monitoring
    - Water quality assessment
    - Bottom characteristics and bathymetry
    - Coral reefs

13. Thermal Infrared Remote Sensing

14. Microwave and Radar Remote Sensing

15. LiDAR Remote Sensing

16. Final Project Presentation