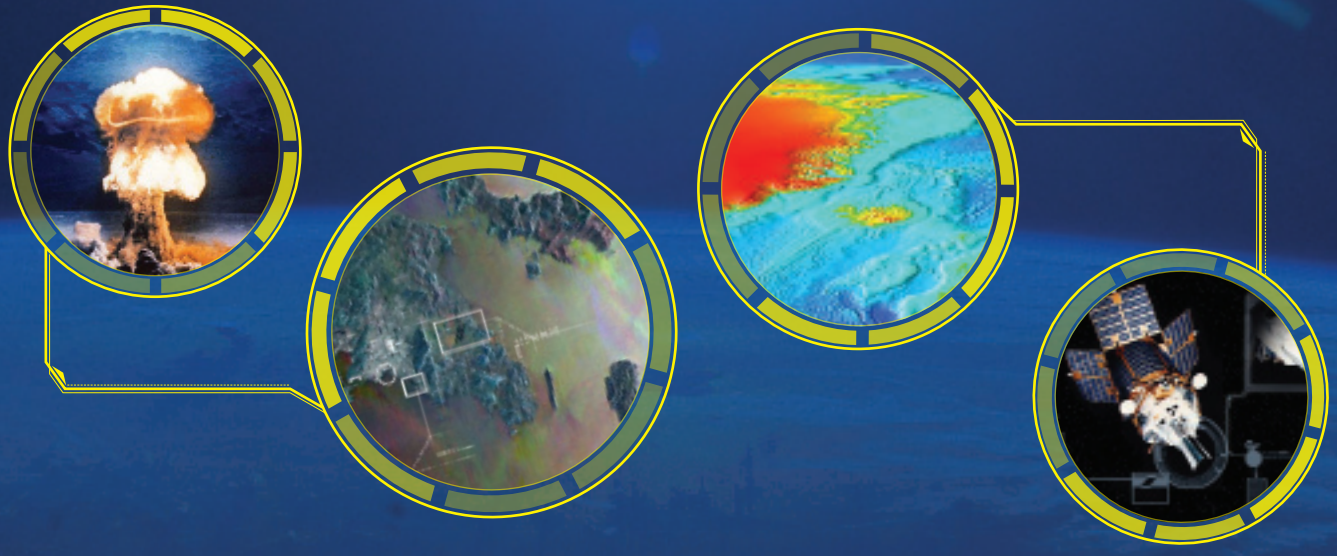
# Air Force Institute of Technology

Center for Technical Intelligence Studies and Research



# AGI IR/SAR Certificate Program

## COURSE CATALOG

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Air Force Institute of Technology
Center for Technical Intelligence Studies and Research
AGI IR/SAR Certificate Program

# A Message From the Director

Since Operation Enduring Freedom, the technical intelligence area known as Advanced Geospatial Intelligence has become a key producer of actionable intelligence for our combat forces. During the early phases of the Afghanistan campaign, the Army's Deputy Chief of Staff for Intelligence (DCS, G-2) praised geospatially derived intelligence information as "extremely valuable" in planning, executing, and assessing the success of combat operations in Afghanistan. AGI supports more than traditional military operations and scientific and technical intelligence. Indeed, AGI has the potential for identifying proliferators of weapons of mass destruction and terrorists employing chemical, biological, nuclear, radiological, and explosive devices. The Department of Defense, State Department, and Homeland Security officials recognize this capability, contributing to exponential growth in the demand for personnel educated and experienced in AGI. At the Air Force Institute of Technology (AFIT), we recognize the significance of our mission to provide defense focused education, research, and consultation. Under the guidance of AFIT's Center for Technical Intelligence Studies and Research, we teamed with National Geospatial-Intelligence College to offer a 17-credit hour certificate program. Focused on the infrared (IR) and radar fundamentals associated with non-imaging IR, multispectral/ hyperspectral and synthetic aperture radar systems, the Center's known as the Advanced Geospatial-Intelligence IR/SAR Certificate Program (ACP) is successfully creating AGI professionals for the benefit of U.S. national security interests. Those who enroll learn quickly that our professional staff is unrivaled in teaching the mathematics and physics necessary to become proficient in processing and exploiting IR and SAR data. Their supervisors have consistently praised the level of understanding and contributions of their personnel who have earned the Certificate in IR/SAR Technologies. Additionally, when the GEOINT Analyst Certification Program for the NSG is established, these courses will certify the highest level of education in these technologies. We hope you and your supervisor find this catalog useful in preparing you for a rewarding career in this exciting discipline of geospatial intelligence.

**Ron Tuttle, Ph.D.**
**Director, Center for Technical Intelligence Studies and Research**

OENG 530
3 Credits

# Fundamentals of Infrared Phenomenology

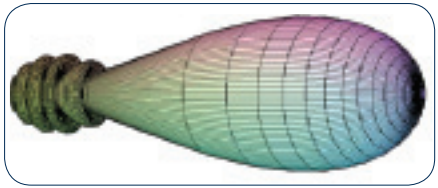
## Description

This course presents the theory of MASINT/AGI data collection with emphasis on IR, MSI/HIS and SAR technology. Phenomenology covered includes source characteristics, radiometry, atmospheric effects, optics, and detectors. A computer lab provides hands-on exercises in calculating source spectra, emissivity and reflectivity, atmospheric transmission, and sensor response.

## Learning Objectives

*After attending this course, the student will be able to:*

- Characterize targets and backgrounds as discrete or continuum sources of electromagnetic radiation, and describe the emissive and/or reflective signatures of sources.
- Calculate and apply radioactive transfer equations and atmospheric transmissions functions
- Define and calculate sensor field of Regard (FOR), Field of View (FOV), Instantaneous Field of view (IFOV), ground Sample Distance (GSD), Point Spread Function (PSF), and spatial resolution.
- Describe and characterize photoelectric focal plane array detectors and evaluate their spatial, spectral, and temporal sampling performance.



## Important

**Length:** 3 weeks [with first week being a Math/Physics review]

**Notes:** This course is the first module in the Advanced Geospatial-Intelligence IR/SAR Certificate Program.

**Dates:** Please visit: **http://www.afit.edu/en/ctisr/acpcourseschedule.cfm**

**Prerequisites:** None

**Clearance Required:** Collateral Secret

**Class Size:** 20 max

# Fundamentals of Infrared Phenomenology Lab

OENG 536
1 Credit

## Important

**Length:** 2 weeks

**Notes:** This is the companion computer lab course to OENG 530, and is to be taken concurrently.

**Dates:** Please visit: **http://www.afit.edu/en/ctisr/acpcourseschedule.cfm**

**Prerequisites:** None

**Clearance Required:** Collateral Secret

**Class Size:** 20 max

## Description

This course provides hands-on exercises in fundamentals of MASINT/AGI data processing and analysis including application of radiation source, propagation, and collection algorithms and techniques. Computing tools include spreadsheets and MODTRAN atmospheric transmissions codes.

## Learning Objectives

*After attending this course, the student will be able to:*

- Calculation of the Planck blackbody function as the standard model of continuum radiation, a function of temperature of an object
- Estimation of an object's reflective signature and exploration of reflectivity as a function of temperature
- Calculation of graybody radiation and the emissivity MASINT signature function
- How to read and interpret the data columns in a typical Formatted Event Data (FED) file MASINT product
- Exploration of the structure and composition of the 1976 US Standard Atmosphere Tables
- Calculation of the atmospheric transmission function using MODTRAN for some typical remote sensing scenarios
- Exploration of how atmospheric transmission depends on altitude, line-of-sight, and atmospheric conditions
- Interpretation of an event's time-intensity history from a FED file as a MASINT signature
- Estimation of an event's metric velocity, acceleration, and state vector from a FED file
- Methods for adding the third dimension to the event trajectory estimation given in a FED

OENG 531
3 Credits

# Overhead Persistent Collection System

## Description

This course covers methods for collecting, processing, analyzing, and exploiting AGI data for missile warning, missile defense, battlespace characterization, support for military operations and technical intelligence using national technical means. Classified information about the national sensors' capabilities will be discussed. The lab portion provides experience and exercises in extracting and interpreting MASINT Formatted Event Data files using commercial and governmental off-the-shelf software. Mission planning is introduced with Satellite Tool Kit (STK®).

## Learning Objectives

*After attending this course, the student will be able to:*

- Describe a space- or aircraft-borne OPIR sensor's components, and calculate its output and signal-to-noise ratio when directed at a target or event of military or national intelligence community interest.
- Describe and characterize the orbits of OPIR sensors and calculate their field of view, distance to target, time over target, and revisit rate.
- Characterize the temporal, spatial, and spectral signatures and metrics of targets and events of interest for order of battle estimates, battlespace characterization, and support to military operations.

## Important

**Length:** 2 weeks

**Notes:** This course is the second module in the Advanced Geospatial-Intelligence IR/SAR Certificate Program.

**Dates:** Please visit: **http://www.afit.edu/en/ctisr/acpcourseschedule.cfm**

**Prerequisites:** Fundamentals of Infrared Phenomenology

**Clearance Required:** Collateral Secret

**Class Size:** 20 max

# Overhead Persistent Collection System Lab

OENG 537
1 Credit

## Important

**Length:** 2 weeks

**Notes:** This course is the second module in the Advanced Geospatial-Intelligence IR/SAR Certificate Program.

**Dates:** Please visit: **http://www.afit.edu/en/ctisr/acpcourseschedule.cfm**

**Prerequisites:** Fundamentals of Infrared Phenomenology

**Clearance Required:** Collateral Secret

**Class Size:** 20 max

## Description

This course provides experience and exercises in extracting and interpreting MASINT Formatted Event Data files using IR Workbench/NOAS/MATLAB® tools and Principal Components background suppression. Mission planning is introduced with Satellite Tool Kit (STK®). The course should be taken in conjunction with OENG 531, Overhead Persistent Collection Systems.

## Lab Objectives

*After attending this course, the student will be able to:*

- An introduction to the fundamentals of Satellite Tool Kit®, a commercial software program for orbit calculation and display
- Directed tutorials in using STK to answer the OPIR collection manager's basic tasking requirements: Where am I? What can I see? When can I see it?
- Using STK to calculate field of regard, field of view, access times, and revisit rates for some OPIR MASINT collection scenarios
- Exploration of the point spread function's appearance on focal plane arrays
- Estimation of actual spatial resolution of an optical system compared to ground sample distance
- Investigate the effect of sensor integration time on reported time-intensity signatures
- Examine the results of changing sensor sampling rates and temporal phasing on the apparent signature of transient events
- Predict and calculate the signature of a transient event as a function of sampling rate and phase

OENG 533
3 Credits

# Multispectral and Hyperspectral MASINT Exploitation

## Description

As the third module of the Advanced Geospatial-Intelligence IR/SAR Certificate Program, this course provides a basis for understanding spectral sensor capabilities, applications, and exploitation techniques. The course examines types of information that can be extracted from multispectral and hyperspectral data sets, and introduces the concepts of signature exploitation for materials identification and scene categorization.

## Learning Objectives

*After attending this course, the student will be able to:*

- Describe the physics and capabilities of spectral dispersive components used in multispectral and hyperspectral sensors.
- Characterize the spectral, spatial, and temporal nature of data sets collected by multispectral imaging (MSI) sensors, and calculate their resolution for target identification.
- Interpret the reflective and/or emissive spectral signatures of targets in MSI data sets as they relate to material identification, activity, and temperature.
- Describe the applications of spectral sensors for surface and littoral characterization, gas cloud/plume identification, land use and environmental evaluation, temperature estimation, and atmospheric sounding.

## Important

**Length:** 2 weeks

**Notes:** This course is the third module in the Advanced Geospatial-Intelligence IR/SAR Certificate Program.

**Dates:** Please visit: **http://www.afit.edu/en/ctisr/acpcourseschedule.cfm**

**Prerequisites:** Fundamentals of Infrared Phenomenology

**Clearance Required:** Collateral Secret

**Class Size:** 20 max

# Multispectral and Hyperspectral MASINT Exploitation Lab

OENG 539
1 Credit

## Important

**Length:** 2 weeks

**Notes:** This is the companion lab course to OENG 539, and is to be taken concurrently.

**Dates:** Please visit: **http://www.afit.edu/en/ctisr/acpcourseschedule.cfm**

**Prerequisites:** Fundamentals of Infrared Phenomenology

**Clearance Required:** Collateral Secret

**Class Size:** 20 max

## Description

This course provides hands-on investigations of Advanced Geospatial-Intelligence spectral phenomenology and data processing algorithms. This course offers exercises in multispectral and hyperspectral materials identification and target recognition using COSMEC/ENVI tools with Landsat, Ikonos, AVIRIS, and other data cubes. Applications to battlespace characterization and target recognition are explored. The course should be taken in conjunction with OENG 533, Multispectral and Hyperspectral MASINT Exploitation.

## Learning Objectives

*After attending this course, the student will understand:*

- Spectral concepts and phenomenology:
  - The effects of atmospheric absorption and scattering in the visible and short-wavelength infrared portion of the spectrum
  - The effects of atmospheric absorption and thermal radiation in the mid and long-wavelength infrared portion of the spectrum
- The following MSI processing algorithms and techniques:
  - Three-band false color composites
  - Scene classification using spectral cluster diagrams and regions of interest
  - Spectral comparison using minimum distance and spectral angle criteria.
  - Capabilities using readily available MSI / HSI spectral algorithm toolboxes, such as ENVI and COSMEC.

EENG 532
3 Credits

# Introduction to Radar and Synthetic Aperture Systems

## Description

As the fourth module of the ACP, this course provides the basis for understanding radar systems, including conventional range-azimuth, Moving Target Indicator Doppler, synthetic aperture, phased-array, bistatic, and over-the-horizon radars. The application of MASINT/AGI phenomenology with signature exploitation of radar cross-sections and wideband signal interpretation is emphasized. Examples may be drawn from current National Technical Sensors.

## Learning Objectives

*After attending this course, the student will understand:*

- Understand the science, phenomenology, and technology involved in radar with an emphasis on SAR
- Enable performance estimation based on system parameters
- Recognize the inherent advantages and limitations of radar
- Demonstrate target signature exploitation for MASINT/AGI needs
- Be familiar with common and experimental exploitation tools and radar missions

## Important

**Length:** 2 weeks

**Notes:** This course is the fourth module in the Advanced Geospatial-Intelligence IR/SAR Certificate Program.

**Dates:** Please visit: **http://www.afit.edu/en/ctisr/acpcourseschedule.cfm**

**Prerequisites:** Fundamentals of Infrared Phenomenology

**Clearance Required:** Collateral Secret

**Class Size:** 20 max

# Introduction to Radar and Synthetic Aperture Systems Lab

EENG 538
1 Credit

## Important

**Length:** 2 weeks

**Notes:** This is the companion lab course to EENG 532, and is to be taken concurrently.

**Dates:** Please visit: **http://www.afit.edu/en/ctisr/acpcourseschedule.cfm**

**Prerequisites:** Fundamentals of Infrared Phenomenology

**Clearance Required:** Collateral Secret

**Class Size:** 20 max

## Description

This course includes the calculation and demonstration of radar cross sections for simple and composite targets, and synthetic aperture scene generation. Demonstrations and experience with X-Patch and radar data exploitation tools and techniques will be provided, including quality control and verification, digital elevation map gridding, orthorectification, and multi-color displays. This course should be taken in conjunction with EENG 532, Introduction to Radar and Synthetic Aperture Systems.

## Learning Objectives

*After attending this course, the student will gain practical experience with:*

- SAR images from operational and research systems and synthetic imagery
- Calculation and interpretation of RCS
- Target cueing techniques and procedures
- Analysis and image manipulation tools

# OENG 535
3 Credits

# MASINT for the Warfighter Seminar

## Description

As part of the 10-week Advanced Geospatial-Inteligence IR/SAR Certificate Program, this series of seminars present MASINT topics of interest to the Intelligence community and take advantage of the knowledge and experience of users and practitioners of MASINT IR/SAR products.

## Learning Objectives

*After attending this course, the student will be able to:*

- To provide interaction with leading practitioners and users of MASINT
- Enable performance estimation based on system parameters
- Recognize the inherent advantages and limitations of radar
- Demonstrate target signature exploitation for MASINT/AGI needs
- Be familiar with common and experimental exploitation tools and radar missions

## Important

**Length:** 10 weeks

**Notes:** This course is held throughout the 10 weeks of the Advanced Geospatial-Inteligence IR/SAR Certificate Program.

**Dates:** Please visit: **http://www.afit.edu/en/ctisr/acpcourseschedule.cfm**

**Prerequisites:** Fundamentals of Infrared Phenomenology

**Clearance Required:** Collateral Secret

**Class Size:** 20 max

# Distance Learning

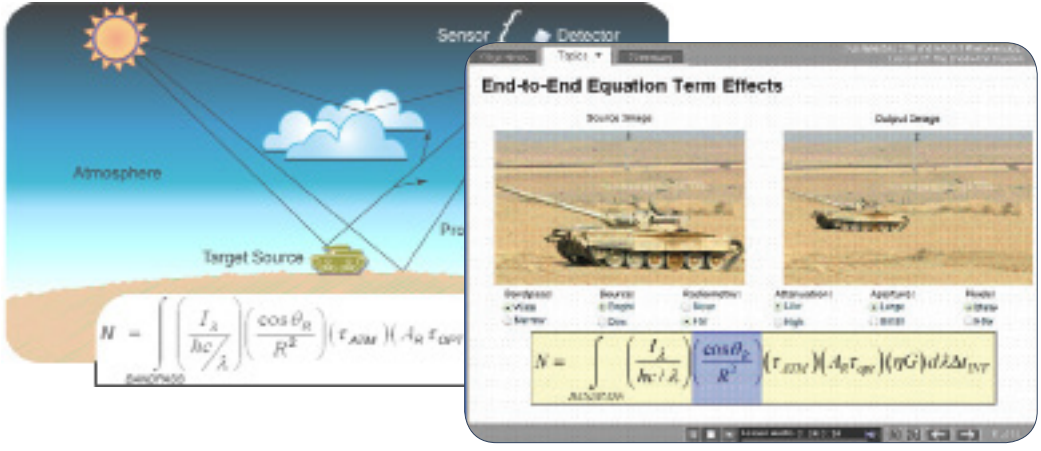
## Important

**Minimum System Requirements**:

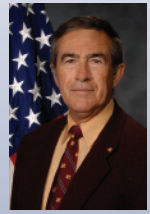
- Broadband connection
- 800x600 minimum resolution
- System speakers
- Flash Player Ver. 10.1
- Adobe Reader
- MS Excel or Excel Reader

## Description

Online versions of OENG 530, OENG 531, OENG533, OENG 536, OENG 535 and EENG 532 are also available. The courses include audio, video animations, simulation, testing and weekly online discussion forums with the professor and other online students. The online courses are equivalent to the classroom courses in content, credit, homework, and testing; however, they are paced over a ten week quarter. This allows students the flexibility to take each course along with other courses or while they are working. Students may take courses from any location that has a system meeting the minimum requirements.*



# Faculty and Administration



**Ronald Tuttle** is the Director of the Center for Technical Intelligence Studies and Research (CTISR) and is an Associated Professor of Nuclear Engineering in the Department of Engineering Physics, Air Force Institute of Technology (AFIT). A retired Air Force Colonel, Dr. Tuttle has 30+ years of experience in technical intelligence, serving as a CBW analyst, nuclear weapons safety officer, principal analyst for the last open-air Chinese nuclear test, director for MASINT and SIGINT activities at two national agencies and special advisor to the Director, National Security Agency.

**Howard E. Evans** II is an Adjunct Assistant Professor of Physics in the Department of Engineering Physics at the AFIT, and a Principal Member of the Research Staff at Riverside Research. He is familiar with the necessity for near real time reliable operational intelligence from a career in the Air Force as a combat aircrew member in the Southeast Asian and European theaters of operations. He has served as the Acting Director for MASINT Data Exploitation at the National Air and Space Intelligence Center and as a Senior Scientist on the COBRA BRASS program with the Ball Aerospace & Technologies Corp. after retirement from 23 years of active duty.

**James Lange** is an Adjunct Associate Professor of Physics in the Department of Engineering Physics at AFIT. He is a Principal Member of the Research Staff at Riverside Research. He has 35+ years in remote sensing techniques, sensors, and data analysis and exploration. These sensing application have involved surveillance, reconnaissance and targeting form various airborne and satellite platforms using sensors in the ultraviolet, visible and infrared, including passive and active sensing techniques fort he visible through the

# Faculty and Administration

**John O'Hair** is an Adjunct Associate Professor of Electrical Engineering in the Department of Electrical and Computer Engineering at AFIT and is a Member of the Professional Staff at Riverside Research. He joins the staff after serving for 21 years in the Air Force where he served in numerous intelligence and research organizations in varying capacities including Intelligence Analyst, Project Engineer and Program Manager. He spent the last 10 years developing and fielding MASINT systems for the Air Force and the Department of Defense.

**Jennifer Vanzant** is a Member of the Professional Staff at Riverside Research and Program Coordinator for the Advanced Geospatial-Intelligence IR/SAR Certificate Program. She joins the staff after serving as the Distance Learning (DL) Coordinator with AFIT's Office of Extension Services for over 2 years. Mrs. Vanzant brings with her a wealth of knowledge and experience from having managed DL programs and providing comprehensive support to both faculty and students.

# Testimonials

"Significant return on our investment! Training time for new hires has been cut in half." - Supervisor of Recent ACP graduate

"The Advanced Geospatial-Intelligence IR/SAR Certificate Program proved to be the ideal training opportunity for [the lieutenant]…he was well-prepared to understand the military significance of foreign sensor developments. He took over for an experienced analyst and was able to contribute to the office mission right from the beginning." - Supervisor of Recent ACP graduate

"…The classes are both mentally challenging and stimulating due to the curriculum of advanced physics embellished with field applications… all of the courses have had significant and direct impact on my job performance, including every SOW I write, designs I review, and specifications and test procedures I evaluate. The payback is significant…" - ACP graduate

"My experience with the ACP program was nothing less than exceptional…By developing a firm foundation as to how and why the technology works, a greater sense of ownership may be instilled throughout the process of image acquisition and delivery to the customer resulting in a higher quality, more efficient product…" - ACP graduate

"With the knowledge I attained from the course, I am truly confident when discussing collection strategies, attaining MASINT data, and analyzing MASINT data for theater analysts." - ACP graduate

# General Information

## Lodging

Rooms are reserved at Wright Patterson Air Force Base Billeting. Confirm with ACP Program Coordinator NLT 3 weeks prior to session start. For non DoD members, contact the ACP Program Coordinator for information on local accommodations.

## Transportation

Students are responsible for providing their own transportation. Classes are held at AFIT; billeting is approximately 5 miles from AFIT; Labs are approximately 3 miles from AFIT.

## Locations

Courses are conducted primarily at the Air Force Institute of Technology, Wright-Patterson AFB, Ohio, and The Defense Geospatial-Intelligence School, FT. Belvior, Virginia.
Unclassified sessions are conducted at AFIT.
Classified sessions are conducted at RRI and AFIT.

## Dates

The following website will give you access to view all current class schedule dates:
**http://www.afit.edu/en/ctisr/acpcourseschedule.cfm**

## Point of Contact

For the most current schedule & information, please contact the Program Coordinator

2640 Hibiscus Way
Beavercreek, OH 45431
Phone: (937) 255-3636x7287
Fax: (937) 255-5342
Email: ctisr@afit.edu

# Enrollment Information

## Courses

All courses, with the exception of Distance Learning courses, are located side-by-side in the catalog with the intention of the courses being taken together. Left pages indicate classroom learning, right pages indicate lab learning.

To enroll, send the following items to the ACP Program Coordinator NLT 3 weeks prior to session start:

## Transcripts

Arrange for official transcripts to be sent from the college or university you are currently enrolled, or from the highest degree granting institution, to the Program Coordinator at :

ACP Program Coordinator
2640 Hibiscus Way
Beavercreek, OH 45431

Unoffical transcripts, sent to the Program Coordinator by fax or email, are acceptable in the interim to meet the deadline.
*If you are an AF Officer contact AFIT Records Dept at 937-255-6234 x3148 to ensure your transcripts are held at AFIT. If they are, you do not need to request/send transcripts.

# Enrollment Information

## Clearances

Minimum collateral secret required. The ACP is for U.S. citizens only. Clearances must be sent to both AFIT and Riverside Research. Please include the following information on visit letters: *Name, Date* and *Place of Birth*, *Citizenship, Purpose of Visit* [to attend ACP]. *Period During Which the Visit is to Be Valid* [perm certs accepted up to one year].

**AFIT** FAX to *AFIT Facilities Security Officer, 937.656.7731*, must be signed by CSSO/FSO.

**Riverside Research** Fax your clearances to *ACP Program Coordinator* at *937.255.5342,* must be signed by CSSO/FSO.

## Tuition

There are no tuition fees (excluding distance learning courses ) or other charges for members of the US intelligence community and its supporting elements for the in-resident ACP Courses. All course materials are provided to students at no charge. TDY costs are the responsibility of the sponsoring organization. Seats are very limited with priority given to DoD/Civilian employees. All applicants are rank-ordered based on submission date of required documents. DoD Contractors may attend, space available, if currently assigned in support of a GEOINT/MAINT related contract (COTR verification/approval required).


www.afit.edu/en/ctisr